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Public Health Reports

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STUDIES ON THE AIR TRANSMISSION OF MICRO-ORGANISMS DERIVED FROM THE RESPIRATORY TRACT

I. *LACTOBACILLUS ACIDOPHILUS* AS A TEST ORGANISM [1]

By H. DU BUY, *Biophysicist*, F. A. ARNOLD, *Dental Surgeon, and* B. J. OLSON *Surgeon, United States Public Health Service*

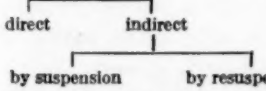
Preliminary studies on the occurrence of *Mycobacterium tuberculosis* in the air immediately surrounding patients with tuberculosis, by testing with air-sampling devices, yielded negative findings. This was in spite of the fact that the cases sampled had extensive laryngeal lesions and the sputa were strongly positive for tubercle bacilli. The need for a nonpathogenic test organism which occurs naturally in the respiratory tract to evaluate these negative results was indicated. For this purpose *Lactobacillus acidophilus* was chosen since it is a normal inhabitant of the oral cavity and can be found in those portions of the upper respiratory tract which come in contact with saliva. This paper reports experiments designed to determine:

(1) Whether or not *Lactobacilli* are expelled from the body by talking, coughing, and sneezing;

(2) Whether or not the *Lactobacilli*, once expelled, are spread either by the direct air-borne route or indirectly by suspension in the air;[2]

[1] From the Laboratory of Physical Biology (formerly the Industrial Hygiene Research Laboratory), Division of Physiology, and Division of Infectious Diseases, National Institute of Health.

[2] Spread of air-borne micro-organisms



Direct air-borne spread—micro-organisms travel in droplets directly from person to person by speaking (mouth droplets), coughing (throat droplets), or sneezing.

Indirect spread by suspension—micro-organisms, leaving person, become suspended by evaporation ("droplet nuclei") and are eventually inhaled by others. (Cornet (*1*), Buchner (*2*), and others.)

Indirect spread by resuspension—micro-organisms leaving person, fall to floor or some solid surface and dry out to particles small enough to be resuspended for varying periods of time dependent on drafts, movements of persons, etc.

(See: Max Neisser, Ueber Luftstaub Infektion. Zts. Hyg. u. Inf. Kr. 27: 175–200, 1898.)

(3) What concentration of *Lactobacilli* naturally present in the saliva is required in order to obtain positive samples from the surrounding air; and

(4) Whether or not, by artificial atomization of bacterial suspensions, results paralleling those observed under natural conditions would obtain.

Previous studies (*3, 4, 5*) have been made in which test organisms from the oral cavity have been used to evaluate various aspects of the air-borne character of disease. The results of these experiments are difficult to evaluate as the source of the organisms cannot be determined with certainty. Futhermore, the number of these organisms varies so greatly, not only from individual to individual but also within one individual over short periods of time, that quantitative studies of little significance.

L. acidophilus seemed to be a desirable organism to use because much of the basic work on its occurrence in the oral cavity has already been done in connection with studies on dental caries(*6, 7, 8*). From these studies the following apply to the present paper:

First, a simple technique whereby *Lactobacilli* can be differentiated from other oral organisms. The method is dependent on the use of 1 percent-dextrose broth (pH 5) and tomato-juice agar pH 5 (*8*). On this medium *Lactobacilli* colonies can be easily distinguished by examination with a dissecting microscope from the few other oral organisms that will grow. In only a few cases is it necessary to revert to stained smears in order to establish colony identity.

Second, by use of this technique it is possible to classify individuals into various groups having widely different numbers of *Lactobacilli* naturally present in their saliva. These counts range from 0 to 100,000 and in some cases reach over 1,000,000 organisms per ml.

Third, the number of *Lactobacilli* in an individual's saliva remains relatively stable from day to day. Although negative cases do sometimes become positive, and vice versa, these changes occur gradually and over a period of weeks *(9, 10)*. This fact suggested that it might be possible to establish quantitative relationships:

(1) Between the number of *Lactobacilli* in the respiratory tract of subjects, and the number in the air surrounding them; and

(2) Between the number of *Lactobacilli* in an atomizer and the number in the air surrounding the instrument after atomization under controlled conditions. Thus the conditions which govern the spread of *Lactobacilli* from the respiratory tract into the air should yield useful information on the conditions required to render air-borne other organisms which also occur in the respiratory tract.

MATERIALS AND METHODS

Test organism.—A strain of *L. acidophilus* isolated from the saliva of one of the authors was used.[3] It was maintained throughout the period of study on tomato-juice agar plates (pH 5). Suspensions were made by harvesting the surface growth of two plates incubated at 37° C. for 48 hours with saline (unless otherwise specified). These saline suspensions were adjusted to approximately the same bacterial concentrations as determined by either nephelometer readings or direct cell count.

Saliva counts.—The following technique was used to determine the number of organisms present in the mouths of the subjects used in these experiments:

Each individual was given a small piece of paraffin to chew, and asked to expectorate a sample of saliva into a 50-cc. wide-mouth screwcap vial; the chewing of paraffin facilitated expectoration and guaranteed a representative sample of micro-organisms from the oral cavity. About 15 ml. of saliva was collected in 5 minutes. The saliva sample was then shaken for 2 minutes on a shaking machine. One ml. of saliva was added to 4 ml. of 1-percent dextrose horse-meat infusion broth (pH 5), mixed with the aid of a pipette, and 0.1 ml. of this mixture was spread uniformly over the surface of a tomato-juice agar plate by use of a sterile glass rod. The plate was incubated 96 hours at 37° C, and the number of *Lactobacilli* colonies were counted by use of a wide-field dissecting microscope.

Counting bacterial suspensions (pure cultures).—The usual pour-plate technique was employed using pH 5 tomato-juice agar to determine the number of viable bacteria. All dilutions were made in saline, and 10 plates made of each dilution counted.

Air-sampling methods.—Two collecting methods were employed: (1) standard size open Petri dishes (9 cm. diameter) containing tomato juice agar, and (2) modified Folin bubblers containing either 10 ml. of saline or 10 ml. pH 5 meat infusion dextrose broth through which a quantity of air measured by flow meter was bubbled.[4]

After exposure the open plates were incubated at 37° C. for 96 hours. The total bacterial counts and the *Lactobacilli* counts were made by means of a wide-field dissecting microscope. After air-sampling with bubblers, their contents were transferred to the trap; 5 ml. of saline was added through the bubbler tube, and its walls washed five times with this saline by means of a 1-ml. pipette. The walls of the bubbler were washed by vigorous shaking of the saline which was then added to the liquid in the trap. A count of the viable organisms in this sampler was made; the pour plate technique using ten plates was

[3] The strain of *L. acidophilus* used in these studies was similar in morphology and colony form to Hadley's group II (7).

[4] The modified Folin bubbler (*11*) was further modified by the addition of a secondary widening of the neck portion approximately 1.5 cm. above the collecting bulb. This feature materially decreased the loss of liquid into the trap.

followed. Dilutions were made whenever necessary. The plates were incubated 72 to 96 hours at 37° C. The total number of bacterial colonies and the number of *Lactobacilli* colonies were counted as described above. The tables present only the results regarding the *Lactobacilli* counts. Impinger-type air-sampling devices were not used since the media favored excessive mold growth.

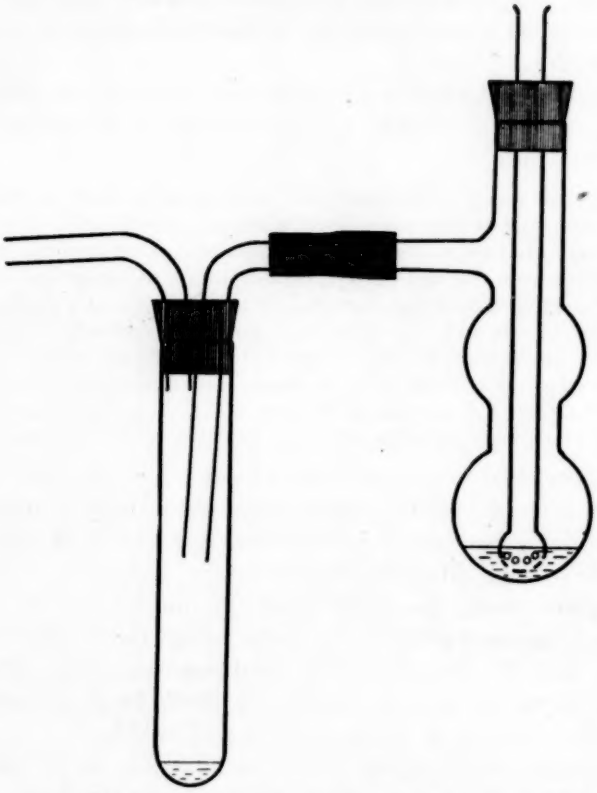


FIGURE 1.—Bubbler air sampler, modified Folin type, or aeroscope, with trap.

Atomization.—In the preliminary work, the failure to recover bacteria from the air (where they were expected to occur as droplet nuclei) made necessary a study of the behavior of the test organisms in the form of droplet nuclei. An aspirator-type atomizer was selected which would produce a predominance of droplets of such dimensions as would be readily airborne at the same time retaining the larger droplets. Such an atomizer was found in the Graeser atomizer, modified by Buchbinder (*12*) (fig. 2). In this atomizer an air current

passes the surface of a bacteria-containing liquid at high velocity[5] and nebulizes the suspension, the stream of minute droplets and vapor goes through the widened part of the atomizer and finally enters the room through the outlet tubing at about one-thirtieth the original velocity. Thus a certain number of bacteria are retained for various reasons (collision with the sidewalls, evaporation of bacteria-laden droplets caught on the walls, etc.). These conditions are aerodynam-

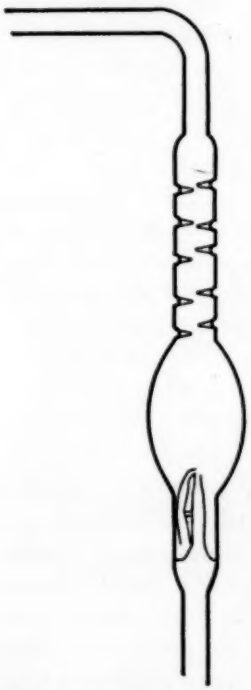


FIGURE 2.—Atomizer, modified by Buchbinder, in which the baffle retains most of the coarse droplets, and which allows atomization of as much as 12 ml.

ically somewhat similar to those occurring in the oral cavity, where the pulmonary air current is converged to pass through the laryngeal outlet and strikes the bacteria-laden moist surfaces of the membranes of the pharynx. This air current is slowed down upon entering the widening buccal cavity and is again accelerated on its passage through the lips or nose. The extent to which such an analogy is valid is debatable because of the aerodynamic complexity of the human respiratory tract.

[5] The inside diameter of the atomizer outlet is 11 mm.; its cross-section area, 95.03 mm.^{2}. At the velocity of 1 cm. per minute, 0.95 ml. would pass per minute through the outlet. Actually 1 cubic foot or 28,300 ml. pass per minute through the outlet. The over-all velocity is, therefore, 29,789 cm. per minute or 17.87 km. per hour. The inside diameter of the aspirator tube is 2 mm. The air velocity in this case is about 566 km. per hour.

EXPERIMENTAL

1. *Determination of the number of* Lactobacilli *expelled from the human mouth.*

Subjects were placed at a laboratory work bench each having in front of him on the bench 9 to 20 open Petri dishes at a level 8 inches below his mouth. One bubbler sampler with the inlet at mouth height was placed at a distance of about 6 inches directly in front of each subject. The air was drawn through the bubbler sampler at the rate of 1 cubic foot per minute. During the 20-minute sampling period the subjects while chewing paraffin were required to pronounce the letters f, s, p, and t at the rate of 96 to 120 letters per minute. These consonants were chosen because their "jet velocity" is the highest of the letters of the alphabet (*13*). The bacterial counts of the open exposed plates and bubbler samplers were determined as described above. This procedure was also followed when the subjects were required to cough or sneeze a certain number of times.

A typical speaking experiment resulted in two sets of data, namely, the plate counts which represent organisms expelled from the mouth and deposited chiefly by gravity, and the bacterial count of the bubbler sampler which consists of the total number of bacteria in a measured amount of air in front of the individual speaker. Typical results of experiments of this type are given in table 1.

This table shows that the subjects had relatively high *Lactobacilli* counts. Nevertheless, with one exception, no *Lactobacilli* were recovered in the bubbler sample of 20 cubic feet of air collected 6 inches from the mouth of each individual speaking. Positive results were obtained only on the open plates in front of the subjects; an average of 4.3 colonies per plate was found. The distribution of colonies on the individual open plate was typical of a droplet contamination. The plates nearest the speaker had the highest counts and the colonies on these plates were not uniformly distributed but occurred in groups. This was especially obvious in the coughing experiments, in which a total of 93 organisms was found in 3 of the 18 plates counted. These results, obtained with the exposed Petri dishes, support the findings reported about 50 years ago by Fluegge and his collaborators, who used the Petri dish technique for the determination of the spread of artificially implanted *Serratia marcescens* from the upper respiratory tract (*14, 15, 16, 17, 18*).

The counts obtained by us are lower than might be expected on the basis of results reported in other studies (*19, 20, 21*). In regard to the latter, however, attention may be called to the fact that in the present study the index organisms, *Lactobacilli,* necessarily come from the oral cavity only, whereas in other studies the origin of the organisms is uncertain.

TABLE 1.—*Showing the number of* Lactobacilli *recovered from bubblers and open Petri dishes which were exposed for 20 minutes in front of subjects pronouncing aloud the letters s, f, p, and t, or sneezing, or coughing* [1]

Date	Subject number	Number *L. acidophilus* per cubic centimeter saliva	Number of *L. acidophilus* recovered in bubblers	Number of plates exposed	Number of plates counted [2]	Number of plates positive	Number *L. acidophilus* recovered on plates	Remarks
Dec. 4, 1944	1		0	12	12	5	15	s, f, p, t.
	2		0	12	9	2	4	Do.
	3		0	12	9	1	5	Do.
Dec. 27, 1944	1		0	12	9	4	7	Do.
	2		0	12	9	7	31	Do.
	3		0	12	9	4	11	Do.
June 6, 1945	1	126,000	Moldy	9	4	2	3	Do.
	2	165,000	...do...	9	6	4	20	Do.
	4	150,000	...do...	9	6	2	2	Do.
June 21, 1945	1		0	16	14	14	317	Do.[3]
	2		0	16	14	7	25	Do.[3]
	4		0	16	16	3	7	Do.[3]
July 20, 1945	1	25,000	1	16	13	8	42	Do.[4]
	2	[5] 24,525,000	0	16	12	9	253	Do.[3]
	4	175,000	[6] 0	16	12	6	54	Do.[6]
Aug. 1, 1945	1	25,000	[6] 0	20	20	8	17	Do.[6]
	2	206,000	[6] 0	20	19	5	18	Do.[6]
Total				235	193	91	831	
Aug. 8, 1945	1			12	9	2	2	3 sneezes only.
July 20, 1945	2			1	1	1	60	1 sneeze directly in plate.
Aug. 1, 1945	1	25,000		20	20	3	3	Coughing 10 minutes.
	2	206,000		20	18	3	93	
Dec. 27, 1944	1			1	1	1	10	Speaking directly in plate for 5 minutes.
	2			1	1	1	1	
	3			1	1	1	0	
Dec. 27, 1944	1			1	1	1	0	Breathing directly in plate, 10 minutes.
	2			1	1	1	0	

[1] Room temperatures ranged between 73° and 85° F.; relative humidity ranged from 56 to 68 percent.
[2] Difference between number of plates exposed and number counted represents those plates overgrown with molds.
[3] Subject used deliberate "wet" speech throughout speaking period.
[4] Occasional sneeze during the 20-minute speaking period.
[5] Subject gargled with suspension of *Lactobacilli* prior to experiment.
[6] After removing an aliquot for counting, the remaining portion of the bubbler medium was incubated or 48 hours, at which time it was found positive for *Lactobacilli*.

The second observation made in this series of speaking experiments is that *Lactobacilli* were not recovered in the bubbler devices used to sample the air around the speaker. The results with oral *Lactobacilli* do not support Wells' explanation (*22*) of the low recovery observed by Fluegge, namely, that most of the bacteria expelled from the mouth would become suspended in the air as droplet nuclei and only a few would fall directly to the open plates.

The recovery of only a few *Lactobacilli* on the open plates and none in the air samplers could be explained by the fact that the concentration of *Lactobacilli* in the mouths of the subjects was too low for a detectable number to be expelled. This raised the question of how many organisms had to be available under experimental conditions for atomization into the air in order to recover consistently positive air samples. To obtain information on this question it seemed best to atomize suspensions with known numbers of *Lactobacilli* into an experimental room.

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2. *Determination of the number of* Lactobacilli *expelled from an aspirator atomizer.*

Chamber experiments were conducted in which *Lactobacilli* were suspended in saline, broth, mucin, serums, and purulent exudate [7] in various concentrations and atomized into an experimental chamber 82″ x 116″ x 94″, or about 500 cubic feet (*23*), and the air was then sampled with open plates and with bubblers.

The bacterial suspensions were atomized for a period of 20 to 25 minutes. Samples were taken at 30- to 40-minute intervals *after the start* of atomization. The open Petri dishes were exposed for 20 minutes at each time interval, and the bubbler samplers were operated at the rate of 1 cubic foot per minute for the same period. The results of a few experiments of each series are presented in detail in table 2, and a summary of the results of all experiments is shown in table 3. It may be noted (table 2) that broth and mucin used as the collecting menstrua in the bubblers consistently yielded higher counts than saline. For this reason the average of the counts obtained from the bubblers containing broth are summarized in table 3. It can be seen from these results that the number of bacteria recovered from the chamber air decreases with each time interval, from one-tenth to three-tenths of the previous value in both bubbler and plate samples. As could be expected, there is a direct relationship between the number of organisms originally in the atomizer and the number recovered, although the variability is considerable. Under the conditions of these experiments, the fluid to be atomized must contain between 200,000 and 1,000,000 organisms per ml. in order that a measurable number of organisms may be recovered from the air into which the fluid is atomized by the sampling methods used.

The variability in the results is too great in this series to draw any definite conclusions regarding the effect of the atomizing medium on the recovery of *Lactobacilli*. It was thought, however, that this variability might in some way be associated with those factors which caused the great discrepancy between the number theoretically atomized and the number calculated to be present in the room. For instance, in experiment No. 14, 1,345,000,000 ($9 \times 149.5 \times 10^6$) organisms were atomized into the room (as based on the amount of liquid disappearing from the atomizer). Yet samples taken 5 to 10 minutes after atomization ceased showed only about 24,138 organisms per cubic foot, or 12,069,000 for the room. The number of bacilli in the suspension which was added to the atomizer was always determined, but the discrepancy between the number of organisms expected in the air

[7] These substances were chosen in order to simulate the consistency of suspending media in the human throat as it might be expected to occur in normal and pathological conditions. The "purulent exudate" was obtained by injecting aleuronat suspended in a starch solution into the pleural cavities of rabbits. The animals were sacrificed after 24 hours and the exudate obtained.

samples and a number found made it necessary to know how many bacteria actually left the atomizer.

Measurement of the atomizer output.—In order to measure the output of bacteria by the atomizer, its outlet was directly connected by a piece of rubber tubing with two bubbler samplers in series. Ten ml. of a *Lactobacilii* suspension was atomized for 20 minutes. After atomization the number of bacteria in the residue of the atomizer and in the liquid of both bubblers was determined by plating. The results are presented in table 4.

It can be seen from these results that:

First, there is a considerable difference between the number of organisms present in the atomizer before atomization and the number found in the bubblers after atomization.

Second, bacteria are more readily atomized when suspended in serum or saliva than in saline, and mucin is a deterrent to atomization.

Third, the number of organisms present in the atomizer after atomization is considerable and does not bear a fixed relationship to the number originally present.

The results show that the number of organisms leaving the atomizer is dependent on the number originally present, but that the number which is left behind shows considerable variability. It was thought that this variability might be due to the manner of atomization by which the larger droplets are thrown against the glass walls of the atomizer, whereas the smaller droplets are expelled carrying numbers of bacteria which bear a direct relation to the concentration of the suspension. The liquid from the larger droplets on the walls will evaporate, leaving the bacteria behind. Subsequent washing resuspends these bacteria in varying degrees, causing a great variability in the count of the residue. Experiments were performed in order to determine whether this "plastering effect" was a characteristic of bacteria or whether it was a general phenomenon due to the type of atomizer used, and also to determine the influence of the suspending medium on this phenomenon.

3. *Atomization of nonliving particles in suspension and of true solutions.*

The amount of suspended material expelled by the atomizer was determined in order to compare atomization of nonliving particles with expulsion of bacteria. Arrowroot starch was tried as a test material since this type of starch has grains of uniform size. Five ml. of saline were mixed with 5 ml. of a starch suspension (5 gm. starch per 20 gm. distilled water). This suspension was added to the atomizer together with a few drops of iodine in a solution of potassium iodide and atomized at the rate of 1 cubic foot per minute for 20

TABLE 2.—*Detailed results of a few experiments on atomization of bacterial suspensions into a closed chamber (82"x116"x94"). These data show the number of bacteria put into the atomizer, the number and percent recovered in bubbler air samplers operated at the rate of 1 cubic foot per minute for a period of 20 minutes and the average number of bacteria recovered on open Petri dishes. Bubblers and Petri dishes were exposed at certain intervals after beginning of atomization*

Atomization				Recovery								Room conditions	
					In bubblers					Open Petri dishes			
Experiment No.	Bacteria count in atomizer per milliliter	Number milliliters atomized	Suspending media	Time after start of atomization (in minutes)	Medium [1] in bubblers	Average number bacteria per milliliters	Milliliters of liquid recovered	Dilution counted	Number bacteria recovered per cubic foot	Recovered in percent of number atomized	Average of 10 dishes	Temp. ° F	Relative humidity (in percent)
15	10.94×10^{8}	9.0	Saline	30	B_5	143.5	10.6	10^{-1}	761.0	0.000770	432.0	80.5°	59
					B_5	124.0	11.4	10^{-1}	707.0	.000720			
					M_5	272.0	10.8	0	147.0	.000150			
				60	B_5	18.5	11.6	10^{-1}	107.0	.000110	91.0		
					B_5	29.5	11.2	10^{-1}	165.0	.000170			
					M_5	6.4	11.3	10^{-1}	36.2	.000040			
				90	B_5	43.3	11.1	0	24.1	.000024	25.0		
					B_5	121.0	10.8	0	65.4	.000066			
					M_5	21.8	12.1	0	13.2	.000013			
11	0.022×10^{8}	9.0	Saline	60	B_5	0.0	12.0	0	0.0	.000000	0.0	82°	63
					B_5	0.0	12.3	0	0.0	.000000			
					S_7	0.0	12.1	0	0.0	.000000			
					S_7	0.0	12.3	0	0.0	.000000			
				120	B_5	0.0	11.5	0	0.0	.000000	0.0		
					B_5	0.0	11.5	0	0.0	.000000			
					S	0.0	12.6	0	0.0	.000000			
20	4.7×10^{8}	8.3	Mucin 2 percent	30	B_5	63.7	11.2	10^{-1}	357.0	.000920	199.0	81.5°	48
					B_5	74.8	11.4	10^{-1}	427.0	.001090			
					M_5	25.0	11.9	10^{-1}	149.0	.000380			
					M_{5+D}	26.7	11.7	10^{-1}	156.0	.000400			
				60	B_5	90.5	9.7	0	43.9	.000112	28.0		
					B_5	35.6	11.5	0	20.5	.000053			
					M_5	19.5	11.6	0	11.3	.000029			
					M_{5+D}	36.0	11.3	0	20.4	.000052			

				90	B_5	9.5	11.0	0	5.2	.000013	7.		
					B_5	3.7	10.8	0	2.0	.000005			
					M_5	.8	11.6	0	.5	.000001			
					M_{5+D}	7.7	11.3	0	4.4	.000011			
12	5.0×10^{6}	4.5	Mucin 5 percent	60	B_5	30.5	11.7	0	17.9	.000079	2.8	80°	53.5
					B_5	36.5	11.4	0	21.1	.000094			
					B_7	39.3	11.0	0	21.6	.000096			
					B_7	53.0	10.5	0	27.9	.000124			
				120	B_5	4.8	12.0	0	2.9	.000013	.5		
					B_5	5.7	11.6	0	3.3	.000015			
					B_7	7.2	11.5	0	4.2	.000019			
25	4.68×10^{6}	9.8	Serum 90 percent	30	B_5	127.0	11.7	10^{-1}	743.0	.001620	188.0	80°	50
					B_5	121.0	11.9	10^{-1}	720.0	.001560			
					M_5	60.3	12.1	10^{-1}	365.0	.000800			
					M_{5+D}	78.0	11.6	10^{-1}	453.0	.000990			
				60	B_5	10.5	11.8	10^{-1}	61.9	.000135	31.6		
					B_5	6.0	11.6	10^{-1}	34.8	.000075			
					M_5	3.7	11.7	10^{-1}	21.7	.000047			
					M_{5+D}	4.5	11.7	10^{-1}	26.4	.000058			
				90	B_5	10.4	12.8	0	6.6	.000014	10.7		
					B_5	10.3	12.4	0	6.4	.000014			
					M_5	3.0	12.1	0	1.8	.000004			
					M_{5+D}	7.5	12.2	0	4.6	.000010			
29	3.84×10^{6}	7.0	Pus 90 percent	40	B_{5+D}	10.5	11.3	10^{-1}	59.3	.000220	21.7	81°	54
					B_{5+D}	10.2	10.0	10^{-1}	51.0	.000190			
					S_7	0.0	11.3	10^{-1}	0.0	.000000			
					M_5	4.0	11.1	10^{-1}	22.2	.000080			
				70	B_{5+D}	1.5	10.4	10^{-1}	7.8	.000029	2.9		
					B_{5+D}	.7	11.1	10^{-1}	3.9	.000015			
					S_7	0.0	10.7	0	0.0	.000000			
					M_5	10.2	10.8	0	5.5	.000021			
				100	B_{5+D}	3.8	11.7	0	2.2	.000008	1.3		
					B_{5+D}	6.3	11.1	0	3.5	.000013			
					S_7	0.0	11.7	0	0.0	.000000			
					M_5	0.5	11.4	0	.3	.000001			

[1] B_5: collecting medium pH_5 broth.
B_7: collecting medium pH_7 broth.
M_5: collecting medium pH_5 mucin, ½ percent.
S_7: collecting medium pH_7 saline.
D: collecting medium contains 1 percent dextrose.

TABLE 3.—*Results, in summarized form, of experiments on atomization of bacterial suspensions into a closed chamber (82" x 116" x 94"). For complete legend see table 2*

Experiment Number	Atomization: Number bacteria theoretically atomized (in millions)	Atomization: Bacteria count in atomizer per milliliter (in millions)	Atomization: Number milliliter atomized	Atomization: Suspending medium [1]	Recovery: In bubblers: Time [2] (in minutes)	Recovery: In bubblers: Number bacteria recovered: Per cubic foot air	Recovery: In bubblers: Number bacteria recovered: Per cubic foot per million atomized	Recovery: In bubblers: Time [2] (in minutes)	Recovery: In bubblers: Number bacteria recovered: Per cubic foot air	Recovery: In bubblers: Number bacteria recovered: Per cubic foot per million atomized	Recovery: In bubblers: Time [2] (in minutes)	Recovery: In bubblers: Number bacteria recovered: Per cubic foot air	Recovery: In bubblers: Number bacteria recovered: Per cubic foot per million atomized	Recovery: On open Petri dishes: Time [2] (in minutes)	Recovery: On open Petri dishes: Average number bacteria per dish [3]	Recovery: On open Petri dishes: Time [2] (in minutes)	Recovery: On open Petri dishes: Average number bacteria per dish [3]	Recovery: On open Petri dishes: Time [2] (in minutes)	Recovery: On open Petri dishes: Average number bacteria per dish [3]	Room conditions: Temperature in degrees Fahrenheit	Room conditions: Relative humidity (in percent)
14	1,345.5	149.50	9.0	Saline	30	24,138	18.0	60	3,777.0	2.80	90	1,176.0	0.88	30	too many	60	too many	90	907.0	80.0	71
6	360.0	40.00	9.0	do	40	500	1.4				100	10.0	0.03	40	277			100	32.6		
18	104.4	17.40	6.0	do	30	483	4.7	60	20.0	0.20	90	9.0	0.09	30	324	60	69.0	90	20.0	82.0	54
15	98.5	10.94	9.0	do	30	734	7.5	60	136.0	1.40	90	45.0	0.45	30	432	60	91.0	90	25.0	80.5	59
19	66.0	7.77	8.5	do	30	148	2.3	60	17.0	0.26	90	6.0	0.09	30	182	60	41.0	90	13.0	83.5	50
10	3.6	0.40	9.0	do				60	1.8	0.49	120	0.4	0.10			60	0.6	120	0.1	83.0	66
9	1.0	0.11	9.0	do				60	0.3	0.25	125	0.0	0.00			60	1.0	125	0.3	84.0	59
11	0.2	0.02	9.0	do				60	0.0	0.00	120	0.0	0.00			60	0.0	120	0.0	82.0	63
16	604.8	67.20	9.0	M 4 percent	30	7,654	12.5	60	905.0	1.50	90	180.0	0.30	30	1,484	60	272.0	90	60.0	81.0	57
13	70.7	8.84	8.0	M 1 percent				60	55.0	0.78						60	61.0			82.0	60
20	39.0	4.70	8.3	M 2 percent	30	392	10.0	60	32.0	0.83	90	3.6	0.09	30	199	60	28.0	90	7.0	81.5	48
17	37.4	4.16	9.0	M ½ percent	30	201	5.3	60	16.0	0.43	90	4.7	0.13	30	105	60	14.0	90	3.4	81.5	61
12	22.5	5.00	4.5	M 5 percent				60	20.2	0.87	120	3.1	0.14			60	2.8	120	0.5	80.0	54
22	827.0	102.10	8.1	Ser. 6.5 percent	30	21,450	26.0	60	1,511.0	1.80	90	280.0	0.34	30	11,213	60	1,521.0	90	297.0	80.0	48
23	369.5	37.70	9.8	do	30	1,513	4.1	60	180.0	0.48	90	23.5	0.07	30	857	60	212.0	90	57.0	80.5	47
21	314.3	32.40	9.7	Ser. 62.5 percent	30	8,089	26.0	60	2,204.0	6.80	90	298.0	0.95	30	1,414	60	384.0	90	130.0	81.0	48
25	45.9	4.68	9.8	Ser. 90 percent	30	732	16.0	60	48.0	1.05	90	6.5	0.14	30	188	60	32.0	90	11.0	80.0	50
24	3.0	0.31	9.9	Ser. 10 percent	30	7	2.2	60	0.4	0.14	90	0.3	0.10	30	5	60	1.2	90	0.5	81.5	48
26	52.2	58.00	9.9	Ser. 50 percent M 2.5 percent.	35	415	8.0	65	65.0	1.25	95	12.0	0.23	35	65	65	9.0	95	3.0	80.0	49
30	75.3	10.76	7.0	P 90 percent	35	232	3.1	65	33.0	0.44	95	3.6	0.03	35	153	65	24.0	95	3.7	83.0	62
29	26.9	3.84	7.0	do	40	55	2.0	70	5.9	0.22	100	2.9	0.10	40	22	70	3.0	100	1.3	81.0	54
3	1.5	0.17	9.0	Straight saliva				60	0.3	0.20	120	0.1	0.06			60	0.9	120	0.0		

[1] M=pH 6 mucin. Ser.=rabbit serum. P=purulent exudate.

[2] Time after start of atomization.

[3] Averages based on counts of 10 dishes.

4.—*Showing the number and percentage of organisms which could be recovered from (1) two aeroscopes which were directly connected with an atomizer, when a certain amount of bacteria was atomized from various suspending media during 20 minutes, and (2) from the atomizer after atomization. (Columns 5 and 7 present the recovery of bacteria, in percentage of the number originally added to the atomizer.)*

Experiment number	Number of bacteria in atomizer (in millions)	Suspending medium	Number of bacteria in atomizer residue (in millions)	Percent of total recovered in atomizer residue	Number of bacteria recovered from bubbler (in millions)	Percent of total recovered from bubbler
13346	970.0	Saline	313.0	32.3	83.4	8.6
42	565.0	do	419.0	74.2	125.0	22.1
8645	242.6	do	147.0	60.4	28.3	11.7
15645	166.0	do	32.6	19.6	27.3	16.5
37	146.0	do	50.4	34.5	10.7	7.3
40	137.3	do	49.3	35.9	12.7	9.2
44	126.0	do	79.0	62.9	23.2	18.4
43	116.5	do	68.7	59.0	29.1	25.1
42	92.3	do	38.6	41.8	15.7	17.0
41	72.4	do	30.8	42.5	10.1	14.0
27945	51.2	do	28.4	55.4	11.1	21.7
12945	44.8	do	22.9	51.1	7.64	17.1
14945	40.7	do	22.0	54.0	5.24	12.9
20945	22.0	do	14.9	67.5	3.79	17.2
Average						15.6
42	1,809.0	Mucin 5 percent	1,395.0	77.1	186.2	10.0
8845	679.8	do	294.0	43.3	28.8	4.2
44	570.0	do	[1] 1,029.0	180.5	60.6	10.6
44	162.0	do	148.9	91.9	13.9	8.6
43	121.6	do	109.0	89.7	8.1	6.6
38	117.1	do	115.0	98.5	2.06	1.8
41	90.5	do	75.4	83.3	3.65	4.0
42	86.1	do	63.6	73.9	2.23	2.6
26945	71.6	do	48.2	67.3	3.47	4.8
19945	51.7	do	27.2	52.6	1.13	2.2
31745	41.0	do	21.1	51.4	1.24	3.0
26745	30.0	do	11.9	39.6	2.26	7.5
13945	1.4	do	.735	52.5	.11	7.8
Average						5.7
41	74.2	Mucin 2½ percent	58.0	78.1	9.2	12.4
43	276.0	Serum 90 percent	188.0	68.1	52.1	18.9
39	142.5	do	55.9	39.2	21.7	15.2
43	119.3	do	89.2	74.8	35.3	29.6
Average						21.2
161045	61.8	Saliva 90 percent	34.8	56.3	10.8	17.5
171045	41.7	do	22.1	53.1	7.89	18.9
Average						18.2

[1] Original solution prepared from 3-day-old culture.

minutes into a modified Folin bubbler, containing 5 ml. saline and a few drops of the I–KI solution. No blue color could be detected in the bubbler; the bubbler content, after 10 minutes centrifugation, contained only a trace of starch sediment. The color in the atomizer gained in intensity, and nearly all the starch particles could be recovered by centrifugation. Apparently the starch was retained, only water droplets not containing starch grains and water vapor left the atomizer, the starch grains being too heavy for atomization.

A similar experiment using erythrocytes was unsuccessful since hemolysis occurred during atomization. Further experimentation was done using a true solution for the determination of the effect of atomization of a dissolved compound on its distribution over the

atomizer and the bubbler. The substance had to be detectable in saline, in broth, or in other mixtures. The color of broth made the quantitative detection of uranine by spectroscopic means impractical. Likewise, the constitution of the solvent mixture limited the choice of chemically detectable substances considerably. Following a suggestion by Dr. Small,[8] $BaCl_2$ was used. It is readily determined quantitatively by titration using Na_2SO_4 in the presence of Narhodizonate (*24*). A number of determinations of $BaCl_2$ dissolved in the various solvent mixtures gave satisfactory recovery indicating that this compound could be used. Table 5 presents some of the results, showing that a portion of the water evaporates, thus leaving the $BaCl_2$ settled against the sidewalls and increasing the total concentration of the $BaCl_2$ in the atomizer. Another portion of the water is atomized into the bubbler sampler, carrying a certain amount of $BaCl_2$.

TABLE 5.—*Amount of $BaCl_2$ found in atomizer and bubbler sampler after atomization of a solution containing $BaCl_2$.*

Solution before atomization	Time of atomization	Milliliters left in atomizer	Milliliter of 0.1 N $BaCl_2$ found in—	
			Atomizer	Bubbler
3 ml. 0.1 N $BaCl_2$ + 7 ml. saline		6.2	2.48	0.6
3 ml. 0.1 N $BaCl_2$ + 7 ml. saline		4.5	2.5	.8
2 ml. 0.1 N $BaCl_2$ + 8 ml. saline	25 minutes	[1] 2.0	1.1	.9
3 ml. 0.1 N $BaCl_2$ + 7 ml. saline	10 minutes	[1] 6.0	2.8	.6

[1] Approximate number of ml. calculated from calibration curve for atomizer output.

A mucin-starch solution, atomized directly into the sampling device did not show any starch-containing sediment after centrifugation of the sampler liquid. Similarly, the amount of $BaCl_2$ recoverable in the bubbler sampler after 25 minutes of atomization of a 5-percent mucin-$BaCl_2$ solution was only half of the amount which was recoverable from a saline-$BaCl_2$ solution. The experiments show that the "plastering effect" is a general phenomenon when atomization is performed with an aspirator type atomizer with reflux, and confirm the previous finding that mucin is a deterrent to atomization. The results suggested that the great discrepancy between the number of bacteria available for atomization and the number actually recovered (table 4) might be due to the fact that a considerable number of bacteria do not leave the atomizer. These bacteria should be recoverable by washing the atomizer walls. This was attempted in a number of cases.

A typical example of experiments designed to evaluate this "plastering" phenomenon is as follows: A 10 ml. saline suspension containing

[8] L. F. Small, Head Chemist, Division of Physiology, National Institute of Health.

53,000,000 *Lactobacilli* was placed in the atomizer and atomized for a period of 20 minutes into a system of two bubblers connected in series to the atomizer outlet. After this atomization period was completed, it was found that only about 2 ml., 20 percent, of the original suspension, remained in the atomizer, but this residue contained 23,700,000, or 45 percent of the original number of organisms present. The atomizer was then washed with 5 ml. of saline by shaking and rubbing the accessible inner walls with a rubber policeman. This "atomizer wash" suspension was found to contain about 8,000,000 or 15 percent of the original number of organisms. Thus, at least 60 percent of the bacteria never left the atomizer. The small piece of rubber tubing (approximately 3 inches long) which connected the atomizer to the first bubbler was washed with 5 ml. of saline, and this suspension was found to contain 1,165,000, or 2 percent of the original number of bacteria. The contents of the bubblers were treated as described above. About 4,455,000, or 8 percent of the original number of organisms, were found in the first bubbler and only about 11,000, or 0.02 percent, in the second bubbler. The total number of bacteria accounted for in such an experiment was about 37,330,000, or 70 percent of the total number placed in the atomizer.

It may be noted that, although only 20 percent of the original saline suspension was left in the atomizer, 60 percent of the bacteria could be found remaining behind. Since about 10 percent of the total area of the atomizer was accessible to rubbing and this process of cleaning was not standardized, the counts have little quantitative value. However, they serve to indicate one source of discrepancy between the actual and the calculated recovery.

If it had been possible to rub the whole area of the atomizer, the number of the organisms recovered would probably have exceeded 100 percent in most experiments. This variability in the number of bacteria recovered is great and can exceed 100 percent because of the breaking up of the bacterial clusters in the original suspensions during the process of atomization. Evidence that this breaking up of bacterial clusters actually occurs was supplied by microscopic examination of the bacterial suspensions before and after atomization. Invariably a certain number of small clusters were encountered in the suspension before atomization, whereas usually they were absent afterwards. This breaking up of clusters has been shown previously to be responsible for the "high efficiency" of sampling devices of the atomizer type in recovering air-borne micro-organisms (*11*). The number of bacteria recovered in the second bubbler is only 0.02 percent of the number of bacteria recovered from the first bubbler, indicating that nearly all atomized organisms retainable by the bubblers were retained by the first bubbler.

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Our data on the number of bacteria which remain in the atomizer show that the behavior of bacteria in this respect is intermediate between the behavior of arrowroot starch, of which nearly all remains behind, and that of $BaCl_2$ in solution, of which half is recovered in the bubbler sampler after 25 minutes of atomization, although 80 percent of the original liquid is atomized. From the above results it is clear that the best reference number available for the study of the behavior of a known amount of bacteria atomized into the air is the number of organisms which can be recovered in a sampler which is directly connected with the atomizer. This number represents the number of bacteria which actually leave the atomizer when a similar bacterial suspension is atomized into a room. On the basis of these results the experiments which follow were performed.

4. *Determination of the number of bacteria recoverable after atomization of a known number into the air.*

A bacterial suspension was prepared to be used in atomization and divided into two equal portions. One portion was atomized at the side of a wall bench in a laboratory which was thoroughly cleaned beforehand and where all stray air currents (from windows, ventilators, etc.) were eliminated as far as possible. The spread of the organisms in the air of the laboratory room by this atomization was determined by placing three bubblers at a distance of 1, 3, and 6 feet, respectively, from the opening of the atomizer (table 6—bubbler samples 1, 2, and 3). Care was taken that the inlets of the bubbler samplers were in line with the outlet opening of the atomizer, i. e., 20 inches above the bench. Two rows of Petri dishes were placed 6 inches apart on the bench in such a manner that the first pair of Petri dishes was placed 1 foot behind the outlet of the atomizer and the following pairs at 6-inch intervals from each other along the work bench (table 6—Petri dishes, positions A and B). Additional plates were placed at two other locations[9] in the room in order to obtain some information as to the spread of the organisms throughout the room (table 6—positions C and D). A bacterial suspension was atomized into the room for 20 minutes, with the Petri dishes exposed and the bubblers operated during this period. Five to 10 minutes after termination of the atomization a second set of plates was exposed and one bubbler sample was taken in order to determine the number of organisms still remaining and settling from the air (table 6). Bacterial counts were made of the suspension added to the atomizer, of the suspension remaining in the atomizer after spraying, and of the liquid obtained from the bubbler sampler. Dilutions were made if necessary, and the bacterial count determined by the pour-plate method.

[9] These locations were at a 30° angle from the line of atomization and the positions of the plates were 8 feet and 15 feet, respectively, from the atomizer outlet.

TABLE 6.—*Showing the number and percent of bacteria recovered in modified Folin bubblers operated at the rate of 1 cubic foot per minute and on 34 open Petri dishes, exposed during 20 minutes of atomization and 5 to 10 minutes after atomization of a certain number of bacteria into a room; also results obtained 5–10 minutes after atomization*

Atomization			Recovery										Room conditions	
			In bubblers					On 34 open Petri dishes						
			Number											
Experiment number	Suspending medium	Number bacteria atomized in room [1]	Sampler 1	Sampler 2	Sampler 3	Percent recovered [1]	Number after 5–10 minutes	Position A and B	Position C	Position D	Percent recovered [2]	Number after 5–10 minutes	Temperature in degrees Fahrenheit	Relative humidity (in percent)
1346	Saline	117, 500, 000	3, 046, 000	238, 000	85, 000	2.9	1, 877	26, 300	6, 700	5, 700	0.03	458	78	33
13346	do	83, 375, 000	6, 250, 000	856, 000	96, 000	8.6	2, 037	58, 400	11, 600	12, 000	.10	610	78	33
12945	do	7, 641, 000	1, 675, 000	26, 000	7, 000	14.5	33	4, 800	600	400	.07	17	84	46
8645	do	28, 341, 000	3, 581, 000	494, 000	100, 000	14.7	-------	97, 400	18, 800	15, 400	.35	656	85	80
15645	do	27, 340, 000	2, 274, 000	144, 000	18, 000	8.8	-------	46, 800	-------	-------	.17	-------	89	64
27945	do	11, 085, 000	1, 365, 000	203, 000	48, 000	14.6	225	13, 500	4, 500	2, 800	.19	214	83	69
14945	do	5, 235, 000	816, 000	29, 000	11, 000	16.4	37	15, 200	1, 500	1, 000	.31	5	85	73
20945	do	3, 784, 000	364, 000	50, 000	34, 000	11.8	968	4, 900	500	700	.16	20	77	66
					Average	11.5				Average	.17			
8845	Mucin 5 percent	28, 768, 000	1, 999, 000	148, 900	29, 400	7.6	501	41, 510	7, 514	286	.15	-------	82	59
26945	do	3, 472, 000	226, 300	58, 900	10, 600	8.5	28	2, 930	760	360	.11	14	84	65.5
26745	do	2, 264, 000	169, 200	33, 600	14, 100	9.6	54	4, 044	1, 312	687	.27	7	87	77
31745	do	1, 243, 000	244, 300	34, 200	14, 200	23.5	-------	1, 794	1, 387	1, 224	.35	95	84	74
19945	do	1, 134, 000	141, 500	10, 600	1, 900	13.6	115	1, 040	400	100	.13	4	77	58
13945	do	110, 000	0	0	20	0.0	0	7	7	0	.03	0	80	56
					Average	12.6				Average	.20			
25645	Saliva 90 percent	22, 094, 000	1, 055, 500	331, 900	31, 800	6.42	290	15, 052	2, 142	1, 462	.05	9	87	72
161045	do	10, 837, 000	503, 600	85, 500	23, 400	5.65	627	3, 292	1, 537	1, 336	.06	56	78	46
171045	do	7, 890, 000	598, 000	65, 700	12, 800	8.57	107	5, 332	680	605	.08	95	79.5	43
					Average	6.9				Average	.06			

[1] Represents the number of bacteria found from similar bacterial suspensions in connected bubbler.

[2] $\frac{\text{Number bacteria recovered}}{\text{Number bacteria atomized}} \times 100$.

The second portion of the bacterial suspension was atomized for 20 minutes into a bubbler sampler directly connected to the atomizer. The number of organisms found in this bubbler was the number assumed to be expelled in the air when 10 ml. of the same bacterial suspension was atomized into the air for the same time under the same external conditions. The number of organisms actually found

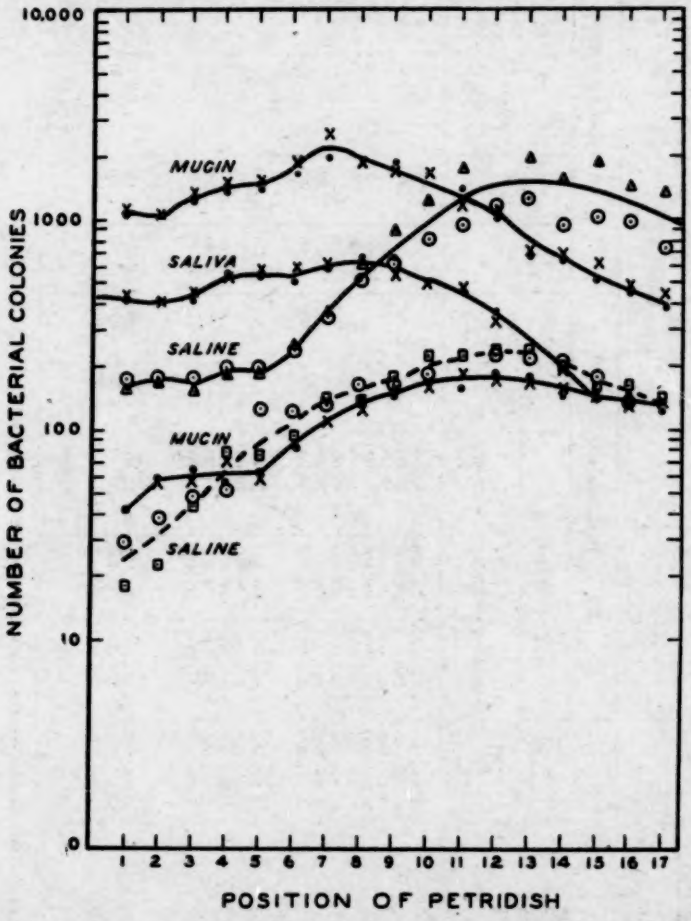

FIGURE 3.—Showing the distribution of Lactobacilli colonies on 2 rows of open Petri dishes placed at intervals of 6 inches along the path of atomization. Position 1 and 2 underneath atomizer. (Data taken from experiments 8845, 25645, 1346, 26745, and 12945 of Table 6).

on the open plates and in the samplers placed at 1, 3, and 6 feet from the outlet of the atomizer was subsequently expressed in percentages of the number found in the connected bubbler sampler. Table 6 presents these results in summarized form.

The results show that the greatest number of the organisms recovered is found in the bubbler sampler placed only 1 foot from the

atomizer (in the saline series an average of 10 percent of the total number expelled). The recovery in bubblers No. 2 and No. 3 is only a fraction of the number recovered in bubbler No. 1, indicating that the organisms settle rapidly. This is further born out by the fact that the maximum of settling on the open plates, which were placed 20 inches below the atomizer outlet, is reached at 4 to 6 feet from the atomizer, as shown on figure 3. An average of 0.17 percent of the total number of expelled organisms was recovered on the 34 open plates in the A and B positions. Apparently, the organisms lost altitude so rapidly that bubblers No. 2 and No. 3, which were placed at the same height as the atomizer outlet, failed to apprehend the organisms which settled on the plates placed below these bubblers. Table 6 further shows that the open plates placed at 8 and 12 feet and not in line with the stream of atomized bacteria (series C and D) apprehended only one-fifth of the number caught by open-plate series A and B. The rapid settling rate is further indicated by the small number of organisms found in both bubblers and plates, exposed 5 to 9 minutes after the end of atomization, being only 0.0001 to 0.000001 percent of the total expelled. For instance, of the 83,000,000 organisms expelled (experiment No. 13,346) only 2,000 organisms were recovered in the bubbler sampler placed at position 2, and 600 organisms on 34 plates exposed around this bubbler. It can further be seen from the table that the minimal number of bacteria *in the air* necessary to recover any organisms at all under conditions of the above experiments is somewhere between 100,000 and 1,000,000. This is roughly half the number which the *suspension in the atomizer* must contain in order to recover any organisms from the air into which the fluid is atomized.

There is some indication that humidity plays a role in that at high relative humidity the organisms settle somewhat faster than at low humidity. However, the variability of the results is too great to draw a definite conclusion in this respect.

In contrast to the results presented in table 4 in which the suspending medium influenced the number of bacteria which could be atomized, the results given in table 6 show that once the organisms have left the atomizer no clear-cut effect of the medium in which they were suspended can be discerned. In general the results of this set of experiments (table 6, figure 3) are in accordance with those obtained from the speaking experiments. They demonstrate that the chance of aerial spread of suspended, bacteria-carrying particles from person to person is very small, but becomes greater at distances within the range of directly expelled particles. Investigations made for a different purpose have shown that the rapid settling rate as demon-

strated for the *Lactobacilli* is also found with air-borne micro-organisms in general when suspended in the air (unpublished material).

DISCUSSION

Quantitative study of the spread of air-borne disease required an easily recognizable, noninfectious test organism, with which pathogens may coexist in the respiratory tract and which could be expected to be spread in the same manner as the pathogens. This is particularly necessary in attempting studies of pathogens, as an example, tubercle bacilli which present serious technical difficulties in their enumeration. *L. acidophilus* is such an organism and was used in the present work. In a series of speaking experiments, the *Lactobacilli* present in the oral cavity of the subjects could not be demonstrated in the surrounding air. This result occurred despite the fact that the organisms were expelled from the mouth, as evidenced by their recovery on open plates.

These findings led to studies on dissemination of *L. acidophilus* suspensions into the air by means of an aspirator-type atomizer. It was found that evaporation of the suspending medium, secondary "plastering" of the organisms on the inner walls of the atomizer, and the kind of suspension medium influenced the number of organisms that could be atomized into the air. Of special interest was the fact that organisms suspended in a mucin solution did not atomize as well as when saline suspensions were employed. This fact is of significance when considering the possibility of disease-producing bacteria becoming directly air-borne from the respiratory tract of the host, keeping in mind the place of origin, i. e., as mouth droplets or throat droplets (*13*). Furthermore, it was found that *Lactobacilli* which become air-borne by atomization stay suspended for only a short period under varying conditions of temperature and humidity. Similar results were found with a mixed air-borne population of bacteria. These results indicate that the air-borne spread of micro-organisms by the direct route is possible only for very short distances. On the basis of the data presented here it might be well to reconsider the results of many studies such as those reported by Wells (*21*) and Hart (*20*), who interpret their data as favoring the spread of air-borne organisms by direct suspension (droplet nuclei).

Experiments on the quantitative relationship between the number of organisms available for suspension in the air and the number recovered from the air indicate that under the conditions of the above experiments, 10^5 to 10^7 organisms per cubic centimeter[3] must be available for suspension in order to yield an air sample from which organisms can be recovered. This explains at least in part the negative

findings of the speaking experiments. The total number of organisms temporarily suspended in the air when speaking, coughing, and sneezing may be considerable. However, when a selective medium is used to test for a specific organism it is found by the method employed that the spread of this organism by direct suspension, immediately following expulsion, is limited. Quantitative studies on other organisms to measure the extent to which the bacteria become air-borne from the upper respiratory tract should be instituted, since our experiments have demonstrated that, at least in the case of *Lactobacilli*, the number of organisms which become directly air-borne is extremely limited. The significance of our results can best be expressed by quoting from Fluegge's review (1899) of the work of himself and his collaborators:

"When we try to draw practical conclusions concerning droplet infection from the results of the experiments, then one had to admit above all, that *a person, by the fact that he is in the neighborhood of a coughing phthisic, can inhale tubercle-bacilli-containing droplets which have been spread in the air by the phthisic during coughing spells.*

"But the experiments teach us at the same time under which conditions and with what limits this manner of infection can occur.

"In the first place, by no means do all phthisics spray droplets. Individual differences, the varying contact of bacilli in the sputum, the time of day, etc., play a role herein. Many phthisics do not seem to spray anything at all; others only during a certain disease period; many only during a certain time of day.

"In the second place, the distance of the inhaling person from the coughing one plays an important role. Up to 50 cm. [about 2 feet] quite strong spraying occurs; from there on the quantity of floating droplets *decreases enormously* [10] in accordance with the distribution of the expelled [by coughing] air in all directions of the air space. At 1.5 m. distance [5 feet] the microscope slides usually remain sterile. However, one is not allowed to conclude from this that no bacteria occur in the more distant airlayers, since the aspirator experiments show that in the long run their presence can be demonstrated, but the dilution is so great that chances of infection are practically entirely absent."[11]

[10] Italics ours.

[11] "Suchen wir auch für die Tröpfcheninfection aus den Resultaten der Experiments praktische Folgerungen abzuleiten, so muss zunachst ohne weiteres zugegeben werden, dass *ein Mensch dadurch, dass er in der Nahe eines hustenden Phthisikers sich aufhalt, tuberkelbacillenhaltige Tröpfchen einathmen kann, welche vom Phthisiker bei den Hustenstossen in die Luft ausgestreut sind.*

"Aber die Experimente belehren uns zugleich darüber, unter welchen Bedingungen und in welchen Grenzen diese Art der Infektion sich vollziehen kann.

"Zunachst streuen bei weitem nicht alle Phthisiker Tröpfchen aus. Individuelle Verschiedenheiten, der wechselnde Gehalt des Sputums an Bacillen, die Tageszeit u. s. w. spielen dabei eine Rolle. Viele Phthisiker scheinen überhaupt nicht auszustreuen; andere nur in einer gewissen Krankheitsperiode; manche nur zu gewisser Tageszeit.

"Zweitens spielt die Entfernung des Einathmenden vom Hustenden eine sehr bedeutende Rolle. Bis auf 50 cm. findet noch ziemlich starke Ausstreuung statt; weiterhin nimmt die Menge der schwebenden Tröpfchen enorm rasch ab, entsprechend der Vertheilung der ausgehusteten Luft nach allen Dimensionen des Luftraumes. In 1½ m. Entfernung bleiben die Objectträger schon fast ausnahmslos frei. Man darf daraus zwar nicht schliessen, dass dann gar keine Bacillen mehr in den entfernteren Luftschichten vorhanden sind, vielmehr zeigen die Aspirationsversuche, dass der Nachweis schliesslich wohl noch gelingt, aber die Verdünnung ist so bedeutend, dass Infektionschancen so gut wie gar nicht mehr vorliegen."

SUMMARY

(1) A series of experiments is reported on the use of *L. acidophilus* as a test organism in studies on air-borne bacteria.

(2) The results indicate that *Lactobacilli* from the upper respiratory tract do not become directly suspended in measurable quantity in the air surrounding an individual while he is speaking, coughing, or sneezing.

(3) An aspirator type atomizer was used to suspend *Lactobacilli* in the air. A considerable number of organisms subjected to atomization were retained in the atomizer under conditions of these experiments.

(4) The results of the atomization experiments show that a reliable value for the number of organisms expelled from a liquid bacterial suspension into the air can be obtained by atomization of an aliquot portion of the suspension into samplers directly connected to the atomizer.

(5) The media in which bacteria are suspended were found to influence atomization. A mucin suspension was found to be the most difficult medium used in these experiments from which bacteria could be suspended in the air.

(6) *Lactobacilli* which become suspended in the air from a liquid medium, either by natural or artificial means, settle out of the air at a very rapid rate.

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See also:

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A CASE OF Q FEVER PROBABLY CONTRACTED BY EXPOSURE TO TICKS IN NATURE [1]

By Carl M. Eklund, *Surgeon (R)*, R. R. Parker, *Director*, and David B. Lackman, *Senior Assistant Scientist, Rocky Mountain Laboratory, United States Public Health Service.*

Q fever, possibly contracted from a tick (*Dermacentor andersoni*) has been observed in a 24-year-old male, who on March 28, 1947, was in Chaffin Creek Canyon in the Bitterroot Mountains, 20 miles southwest of Hamilton, Mont. Ticks were numerous and those removed from his clothes were destroyed by being crushed with his fingers. Slight malaise was noted on April 13, and during the night he awakened feeling warm. The next day headache and malaise were present. During the evening of April 15, he had a severe chill. Chills recurred the evenings of April 16 and 17. A physician was consulted on April 17. His impression was that the patient had influenza. On April 18 the patient felt better, but next day the symptoms reached their greatest severity. The patient felt better again on April 20; on April 21 the headache was gone for the first time and the patient felt well except for weakness. From then on improvement was progressive. The prominent symptoms were head-

[1] From the Rocky Mountain Laboratory, Hamilton, Mont., Division of Infectious Diseases, National Institute of Health.

ache, malaise, great difficulty in sleeping, and marked sweating during the night. Headache was continuous throughout the illness and seemed to be centered in back of the eyes. The patient felt fairly well in the morning but during the day became progressively more tired. Appetite was poor during the entire illness and there was a loss of weight of 10 pounds. Sweating at night was severe and appeared to follow the taking of aspirin. The patient was able to be up each day during the illness, but difficulty in sleeping was so marked that he disliked going to bed at night. A blood specimen was obtained April 21. At that time the patient appeared pale and showed evidence of weight loss, but stated that he felt well except for some weakness.

Laboratory examination.—On April 21 the white blood count was 8,000 with 60 percent polymorphonuclear leucocytes. The hemoglobin was 15.3 grams. Blood serum obtained on this day was negative for agglutinins for *Pasteurella tularensis*, Q fever rickettsiae, and sheep red cells. Agglutinins for *Brucella abortus* were present in insignificant titer. Further samples of serum were obtained on May 7 and May 21. No significant agglutinins for *P. tularensis* or *B. abortus* were observed in either of these specimens, and a Weil-Felix agglutination test was set up with the last specimen with no significant findings. The results of rickettsial complement fixation tests are summarized in table 1 and the results of rickettsial agglutination tests in table 2. Tests with other than Q fever antigens were negative.

TABLE 1.—*Results of complement fixation tests with Q fever antigens. Dilution of serum giving complete fixation with 2 units of antigen*

Serum			Antigen			
	Samples obtained		Henzerling strain (Italian)	Australian strain	Paige strain (Italian)	Original American strain
	Date	No. days after onset				
1	Apr. 21	8	0	0	0	1:16
2	May 7	24	1:512	1:256	1:256	1:512
3	May 21	38	1:512	1:128	1:512	1:512

TABLE 2.—*Results of agglutination tests with suspension of Q fever rickettsiae (Australian strain)*

Serum	Date sample obtained	Antigen			
		1:10	1:20	1:40	1:80
1	Apr. 21	0	0	0	0
2	May 7	4	4	4	1
3	May 21	4	4	4	2
Normal human	----------	0	0	0	0
Q fever, guinea pig	----------	3	3	2	0

Because of the positive complement fixation obtained with the second specimen, 1 ml. amounts of the first serum (which had been stored in the refrigerator for 18 days) were injected intraperitoneally on May 9 into each of two guinea pigs, one of which showed a rise in temperature on the ninth day, the other on the tenth. One animal was killed on the fourth day of fever. The spleen was found to be about three times normal size, and rickettsiae were observed in impression smears. A suspension of liver and spleen from this animal was injected into 6 guinea pigs. Fever was observed in this group on the third day. The strain is now being carried in serial passage in guinea pigs. The second animal injected with the patient's serum recovered. This guinea pig and a second passage animal were each bled on the twentieth day after inoculation and their serums used for complement fixation tests for Q fever. Both serums were positive in a dilution of 1:256. The second animal originally inoculated and recovered passage animals were immune to subsequent inoculation with an American strain of Q fever.

Epidemiological data.—The patient lives in a small apartment in the business section of the town where there is no opportunity for contact with animals. When the weather is favorable his time is spent in taking pictures of mountain scenes, wild animals, and flowers; the remainder of his time is spent in town. During the few weeks prior to his illness, the weather had been stormy and his trips into the mountains had been few. Over a month prior to his illness he had handled dead mountain lions, and three days before his illness, dead beavers. He had had no contact with cattle. The contact with ticks on March 28 appears to be the likely source of infection. However, if the patient was infected through the medium of the ticks which he crushed with his fingers, it is obvious that tick bite was not involved. The question therefore arises, could infection have occurred through the contamination of an abrasion or perhaps even of the unabraded skin with infected tick tissue? Whether or not infection can take place in the latter manner, as is the case in Rocky Mountain spotted fever, is unknown.

Spontaneous infection of *D. andersoni* with *Rickettsia burneti* has been reported from Montana and Wyoming (*1*, *2*). Another strain was recovered recently from 27 ticks of this species collected April 10, 1947, from a Rocky Mountain goat shot in Lost Horse Canyon, several miles north of Chaffin Creek Canyon.

There is no proved instance of human infection by the bite of *D. andersoni* or any of the other four species of ticks known to be spontaneously infected in the United States.

Summary.—A case of Q fever is described in which the likely source of infection was contact with ticks (*Dermacentor andersoni*) in nature.

A strain of the Q fever rickettsia was isolated from the first serum specimen by animal inoculation after 18-days storage in the cold room. Successive serum samples showed an increasing titer against Q fever antigen in the complement fixation and rickettsial agglutination tests.

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DEATHS DURING WEEK ENDED AUG. 30, 1947

[From the Weekly Mortality Index, issued by the National Office of Vital Statistics]

	Week ended Aug. 30, 1947	Corresponding week, 1946
Data for 93 large cities of the United States:		
Total deaths	8,388	7,918
Median for 3 prior years	7,918	
Total deaths, first 35 weeks of year	326,903	321,066
Deaths under 1 year of age	713	730
Median for 3 prior years	638	
Deaths under 1 year of age, first 35 weeks of year	26,202	22,309
Data from industrial insurance companies:		
Policies in force	67,218,588	67,282,680
Number of death claims	11,537	10,600
Death claims per 1,000 policies in force, annual rate	8.9	8.2
Death claims per 1,000 policies, first 35 weeks of year, annual rate	9.4	9.8

INCIDENCE OF DISEASE

No health department, State or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring

UNITED STATES

REPORTS FROM STATES FOR WEEK ENDED SEPTEMBER 6, 1947

Summary

The incidence of poliomyelitis increased from a total of 602 cases last week to 826 for the current week, as compared with a decline for the corresponding week last year from 1,780 to 1,726. The 5-year (1942–46) median for the current week is 906. Slight declines occurred currently in the West North Central, South Atlantic, and Pacific areas. Accounting for 70 percent of the current net increase is the report of 195 cases in Ohio (last week 39). Of the 16 States reporting currently 12 or more cases, 12 showed increases and 4 reported decreases, as follows (last week's figures in parentheses): *Increases*—Massachusetts 34 (26), Connecticut 23 (13), New York 95 (53), New Jersey 34 (26), Pennsylvania 33(31), Ohio 195 (39), Indiana 28 (18), Wisconsin 15 (9), Minnesota 29 (19), Virginia 12 (7), Kentucky 15 (0), Tennessee 12 (6); *decreases*—Rhode Island 14 (18), Illinois 87 (93), Michigan 45 (59), California 21 (25).

The total number of cases of poliomyelitis reported during the 25-week period since March 15 (the approximate average date of lowest seasonal incidence) is 4,046, as compared with 13,693 in 1946; 6,650 in 1945, 10,709 in 1944 and 6,490 in 1943 for the corresponding periods. The current figure, the lowest since 1942, when 1,903 cases were reported. In 7 of the past 20 years the peak of reported weekly incidence of poliomyelitis has occurred in weeks ended between September 12 and 19, earlier in 10 years, and later in 3 years.

New York and Pennsylvania each reported 1 case of anthrax. One case of smallpox occurred in Tennessee. Of 40 cases of infectious encephalitis (last week 29), 11 occurred in North Dakota and 9 in California. Of 31 cases of tularemia (last week 14), 24 occurred in the South Atlantic and South Central areas. The total to date is 1,082, as compared with 666 for the same period last year and a 5-year median of 629. A total of 4,247 cases of undulant fever has been reported to date, as compared with 3,540 and 3,330, respectively, for the corresponding periods of 1946 and 1945.

Deaths recorded during the week in 93 large cities of the United States totaled 7,629, as compared with 8,388 last week, 7,914 and 8,120, respectively, for the corresponding weeks of 1946 and 1945 and a 3-year (1944-46) median of 7,914. The cumulative total is 334,532, as compared with 328,980 for the corresponding period last year.

Telegraphic morbidity reports from State health officers for the week ended Sept. 6, 1947, and comparison with corresponding week of 1946 and 5-year median

In these tables a zero indicates a definite report, while leaders imply that, although none was reported, cases may have occurred.

Division and State	Diphtheria			Influenza			Measles			Meningitis, meningococcus		
	Week ended—		Median 1942–46	Week ended—		Median 1942–46	Week ended—		Median 1942–46	Week ended—		Median 1942–46
	Sept. 6, 1947	Sept. 7, 1946		Sept. 6, 1947	Sept. 7, 1946		Sept. 6, 1947	Sept. 7, 1946		Sept. 6, 1947	Sept. 7, 1946	
NEW ENGLAND												
Maine	0	4	1					5	4	1	1	1
New Hampshire	0	0	0					2		0	0	0
Vermont	0	1	1				7	12	4	0	0	0
Massachusetts	3	8	3				8	42	41	2	0	2
Rhode Island	3	0	0		1	1	1	17	5	0	0	1
Connecticut	2	1	1	1			3	10	10	1	2	3
MIDDLE ATLANTIC												
New York	8	8	8	[1] 1	[1] 4	[1] 2	62	86	36	5	3	6
New Jersey	1	5	3			1	25	22	20	0	1	4
Pennsylvania	4	5	4	(2)	[2] 1	[2] 1	15	49	31	3	4	4
EAST NORTH CENTRAL												
Ohio	6	13	6			2	19	31	12	0	2	2
Indiana	7	4	5	27			4	2	6	0	1	1
Illinois	2	9	7		1	3	23	9	10	1	4	4
Michigan [3]	0	6	3				18	22	22	4	1	2
Wisconsin	0	1	0	18	2	9	45	24	27	0	1	2
WEST NORTH CENTRAL												
Minnesota	2	5	5	1			16	2	6	2	0	1
Iowa	0	4	3				4	12	3	0	1	1
Missouri	1	5	3		1		10	7	6	0	4	1
North Dakota	0	0	0	1			4			0	0	0
South Dakota	1	1	3				10	3	2	0	2	1
Nebraska	0	1	1	5	6	5	5	3	3	0	1	0
Kansas	2	8	4		2	2	4	6	4	0	0	0
SOUTH ATLANTIC												
Delaware	0	0	0						1	0	0	0
Maryland [2]	0	4	1		3	1	2	1	7	0	1	1
District of Columbia	0	0	0						2	1	0	1
Virginia	3	7	12	155	90	90	37	18	10	1	2	2
West Virginia	2	4	8	5	1	1	21	2	2	0	2	2
North Carolina	11	7	34				6	5	5	0	1	1
South Carolina	2	2	15	170	49	142	12		10	0	0	1
Georgia	5	14	19	6	9	9		2	2	0	0	1
Florida	6	8	5	1	2		1	5	5	0	1	1
EAST SOUTH CENTRAL												
Kentucky	5	5	5	1			7		4	1	2	2
Tennessee	0	3	12	9	9	6	9	1	4	3	0	1
Alabama	8	8	17	14	22	14	24	3	3	1	1	2
Mississippi [3]	6	8	10	6						0	0	2
WEST SOUTH CENTRAL												
Arkansas	2	5	9	1	9	5	5	3	3	0	1	1
Louisiana	0	4	5	1	2	5	2	5	2	0	0	1
Oklahoma	3	1	6	10	2	2	2		1	0	0	1
Texas	22	16	32	244	186	273	78	19	25	4	1	2
MOUNTAIN												
Montana	0	0	0			1	10	16	2	0	0	0
Idaho	0	1	0	5	6	1	2	2	2	0	0	0
Wyoming	0	0	0					6	5	0	0	0
Colorado	10	3	6	1	7	4	4	9	5	3	0	2
New Mexico	0	3	2				5	8	2	0	0	0
Arizona	5	7	1	17	12	17	8	11	2	0	0	0
Utah [3]	0	0	0				9	6	6	0	1	0
Nevada	0	0	0							0	0	0
PACIFIC												
Washington	3	3	3				6	8	11	1	1	1
Oregon	0	1	1	1	3	2	3	9	18	0	0	1
California	3	18	12	5	2	9	37	38	55	6	6	6
Total	138	221	314	706	432	654	573	543	527	40	48	73
36 weeks	7,527	10,555	8,192	304,493	193,473	83,304	186,075	640,628	540,027	2,602	4,616	6,402
Seasonal low week [4]	(27th) July 5–11			(30th) July 26–Aug. 1			(35th) Aug. 30–Sept. 5			(37th) Sept. 13–19		
Total since low	1,230	1,927	1,746	2,980	3,276	3,276	573	543	527	3,574	6,120	8,854

[1] New York City only. [2] Philadelphia only.
[3] Period ended earlier than Saturday.
[4] Dates between which the approximate low week ends. The specific date will vary from year to year.

Telegraphic morbidity reports from State health officers for the week ended Sept. 6, 1947, and comparison with corresponding week of 1946 and 5-year median—Con.

Division and State	Poliomyelitis			Scarlet fever			Smallpox			Typhoid and paratyphoid fever		
	Week ended—		Median 1942–46	Week ended—		Median 1942–46	Week ended—		Median 1942–46	Week ended—		Median 1942–46
	Sept. 6, 1947	Sept. 7, 1946		Sept. 6, 1947	Sept. 7, 1946		Sept. 6, 1947	Sept. 7, 1946		Sept. 6, 1947 [3]	Sept. 7, 1946	
NEW ENGLAND												
Maine	5	1	2	3	8	8	0	0	0	0	0	0
New Hampshire	0	7	1	3	0	2	0	0	0	1	0	0
Vermont	0	2	3	0	1	2	0	0	0	0	0	1
Massachusetts	34	16	23	17	31	48	0	0	0	7	1	2
Rhode Island	14	7	1	1	1	1	0	0	0	0	0	0
Connecticut	23	8	9	0	0	5	0	0	0	0	1	1
MIDDLE ATLANTIC												
New York	95	101	101	40	59	59	0	0	0	6	14	12
New Jersey	34	15	22	4	12	12	0	0	0	1	2	2
Pennsylvania	33	20	20	17	32	38	0	0	0	4	6	12
EAST NORTH CENTRAL												
Ohio	195	52	33	40	7	61	0	0	0	3	7	7
Indiana	[6] 28	47	23	9	18	16	0	0	0	8	3	3
Illinois	87	199	131	15	39	44	0	0	0	2	2	4
Michigan [3]	45	55	34	10	18	32	0	0	0	1	4	3
Wisconsin	15	130	19	10	29	38	0	0	0	1	0	0
WEST NORTH CENTRAL												
Minnesota	29	199	17	10	11	15	0	0	0	0	0	0
Iowa	10	30	23	5	6	15	0	0	0	0	1	1
Missouri	5	120	21	3	10	10	0	0	0	1	1	3
North Dakota	0	66	7	6	4	4	0	0	0	0	0	0
South Dakota	2	45	1	3	1	1	0	0	0	0	0	0
Nebraska	[6] 11	40	11	48	9	9	0	0	0	1	1	0
Kansas	3	50	13	2	5	18	0	0	0	0	0	2
SOUTH ATLANTIC												
Delaware	6	2	2	2	2	2	0	0	0	0	1	1
Maryland [3]	6	9	5	3	14	14	0	0	0	0	0	2
District of Columbia	0	3	3	0	4	4	0	0	0	0	0	0
Virginia	12	4	9	9	14	23	0	0	0	1	6	10
West Virginia	9	5	5	13	22	32	0	0	0	4	1	4
North Carolina	11	8	8	7	20	36	0	0	0	0	0	3
South Carolina	3	0	3	1	1	5	0	0	0	4	3	6
Georgia	4	7	3	3	5	8	0	0	0	2	3	5
Florida	1	16	0	4	2	2	0	0	0	0	1	1
EAST SOUTH CENTRAL												
Kentucky	15	3	6	5	27	14	0	0	0	14	1	10
Tennessee	12	16	13	8	19	28	1	0	0	9	7	9
Alabama	3	6	4	5	8	19	0	0	0	3	2	2
Mississippi [3]	3	21	4	8	3	9	0	0	0	1	2	4
WEST SOUTH CENTRAL												
Arkansas	7	34	5	1	3	3	0	0	0	6	0	6
Louisiana	1	16	5	3	3	3	0	0	0	6	5	11
Oklahoma	5	33	10	3	4	6	0	0	0	6	2	5
Texas	8	25	25	20	23	22	0	0	0	11	6	10
MOUNTAIN												
Montana	1	5	5	5	8	6	0	0	0	1	0	0
Idaho	5	5	1	6	3	3	0	0	0	1	0	1
Wyoming	3	5	2	0	2	2	0	0	0	0	2	0
Colorado	5	72	23	10	9	9	0	0	0	0	4	2
New Mexico	5	15	3	1	5	3	0	0	0	1	0	2
Arizona	1	7	2	3	3	1	0	0	0	0	1	1
Utah [3]	0	13	13	2	0	3	0	0	0	0	0	0
Nevada	0	0	0	0	0	0	0	0	0	0	0	0
PACIFIC												
Washington	3	28	7	6	9	17	0	0	0	0	1	1
Oregon	8	12	11	5	11	7	0	0	0	0	1	1
California	21	146	30	21	39	42	0	0	0	5	9	5
Total	826	1,726	906	400	564	804	1	0	2	111	101	185
36 weeks	[4] 58	14, 160	7, 047	63, 652	88, 476	100, 121	148	279	311	2, 596	2, 886	3, 762
Seasonal low week [4]	(11th) Mar. 15–21			(32d) Aug. 9–15			(35th) Aug. 30–Sept. 5			(11th) Mar. 15–21		
Total since low	[4] 4, 046	13, 693	6, 650	1, 549	2, 181	2, 746	1	0	2	2, 111	2, 411	2, 946

[3] Period ended earlier than Saturday.
[4] Dates between which the approximate low week ends. The specific date will vary from year to year.
[5] Including paratyphoid fever reported separately as follows: Massachusetts 7 (salmonella infection); Ohio 1; West Virginia 1; Georgia 1; Tennessee 1; Louisiana 2; Oklahoma 1; Texas 2; California 2.
[6] Delayed reports: Indiana 33 cases (nonparalytic), July 27 to Aug. 30; Nebraska 2 cases, week ended July 19. Included in cumulative totals only.

Telegraphic morbidity reports from State health officers for the week ended Sept. 6, 1947, and comparison with corresponding week of 1946 and 5-year median—Con.

Division and State	Whooping cough			Week ended Sept. 6, 1947							
	Week ended—		Median 1942–46	Dysentery			Encephalitis, infectious	Rocky Mt. spotted fever	Tularemia	Typhus fever, endemic	Undulant fever
	Sept. 6, 1947	Sept. 7, 1946		Amebic	Bacillary	Unspecified					
NEW ENGLAND											
Maine	29	3	16								
New Hampshire	4	5									
Vermont	28	10	24								1
Massachusetts	110	113	113		1		2				2
Rhode Island	30	18	18		1						
Connecticut	40	29	43								1
MIDDLE ATLANTIC											
New York	202	126	204	7	6			3	1		6
New Jersey	176	139	139								2
Pennsylvania	178	148	128					1			1
EAST NORTH CENTRAL											
Ohio	357	79	117			1					1
Indiana	48	32	32				3				7
Illinois	113	139	139	2			1				6
Michigan [3]	137	125	125	1							4
Wisconsin	208	185	184								4
WEST NORTH CENTRAL											
Minnesota	66	9	43								4
Iowa	21	31	19				1				
Missouri	25	16	14			2			3		
North Dakota	1	6	6				11				
South Dakota	7	5	5								1
Nebraska		4	12				3				3
Kansas	79	23	23								
SOUTH ATLANTIC											
Delaware	2	7	1								
Maryland [3]	73	43	43					3			
District of Columbia	26	3	7								
Virginia	84	35	41			165	2	5	3		7
West Virginia	24	57	13		2						
North Carolina	35	54	66					2	1		
South Carolina	87	15	63		13					6	2
Georgia	9	4	19		4				2	16	3
Florida	10	25	5			2				4	2
EAST SOUTH CENTRAL											
Kentucky	25	16	29					2			
Tennessee	24	16	22			2	3	1	2	1	5
Alabama	38		3							3	1
Mississippi [3]	6				10				10		1
WEST SOUTH CENTRAL											
Arkansas	13	12	14	7	9	6			4	1	3
Louisiana	11	12	4	3	1					3	
Oklahoma	26	19	9	2					1		2
Texas	329	119	126	12	288	55			1	18	9
MOUNTAIN											
Montana	46	3	7						1		
Idaho	11	2	3				2				1
Wyoming	1	4	4								
Colorado	51	18	30		2		3				8
New Mexico	17	9	9								
Arizona	18	2	3			32					
Utah [3]	19	8	11						2		4
Nevada											
PACIFIC											
Washington	22	30	25								
Oregon	9	4	8								
California	56	36	72	1	9		9				2
Total	2,931	1,798	2,137	35	346	265	40	17	31	52	93
Same week: 1946	1,798			39	186	92	21	20	19	84	95
Median 1942–46	2,137			39	461	386	18	18	14	134	[7] 86
36 weeks: 1947	112,108			2,093	11,308	7,149	365	461	1,082	1,462	4,247
1946	70,100			1,683	12,293	4,834	446	498	666	2,380	3,540
Median, 1942–46	91,006			1,316	12,293	5,620	446	406	629	2,628	[7] 3,435

[3] Period ended earlier than Saturday.

[7] 2-year average, 1945–46.

Alaska, week ended Aug. 30, 1947: Influenza 29, typhoid fever 2, pneumonia 1, septic sore throat 1, mumps, 1, measles 1.

Territory of Hawaii, week ended Sept. 6, 1947: Bacillary dysentery 1, influenza 1, endemic typhus fever 1, whooping cough 18. Correction: Add measles 1, whooping cough 2, to report for week ended Aug. 30, 1947.

Anthrax: New York 1, Pennsylvania 1. *Leprosy*: New York 1, Louisiana 1.

WEEKLY REPORTS FROM CITIES [1]

City reports for week ended Aug. 30, 1947

This table lists the reports from 88 cities of more than 10,000 population distributed throughout the United States, and represents a cross section of the current urban incidence of the diseases included in the table.

Division, State, and City	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
NEW ENGLAND												
Maine:												
Portland	0	0	-----	0	-----	0	1	0	1	0	0	2
New Hampshire:												
Concord	0	0	-----	0	-----	0	1	0	0	0	0	-----
Vermont:												
Barre	0	0	-----	0	1	0	0	0	0	0	0	-----
Massachusetts:												
Boston	4	0	-----	0	12	0	11	20	3	0	0	28
Fall River	0	0	-----	0	2	0	0	0	0	0	0	11
Springfield	0	0	-----	0	1	0	0	1	0	0	0	6
Worcester	0	0	-----	0	-----	0	5	2	0	0	0	6
Rhode Island:												
Providence	0	0	1	0	-----	0	1	9	2	0	0	28
Connecticut:												
Bridgeport	0	0	-----	0	1	0	0	2	1	0	0	1
Hartford	0	0	-----	0	1	0	0	2	1	0	0	-----
New Haven	0	0	-----	0	-----	0	3	2	0	0	0	11
MIDDLE ATLANTIC												
New York:												
Buffalo	0	0	-----	0	-----	1	3	4	0	0	0	8
New York	7	0	2	0	36	3	43	20	12	0	2	86
Rochester	0	0	-----	0	-----	0	0	5	1	0	0	5
Syracuse	0	0	-----	0	-----	0	0	1	0	0	0	16
New Jersey:												
Camden	0	0	-----	0	-----	0	2	5	0	0	0	1
Newark	0	0	-----	0	5	0	1	3	2	0	0	38
Trenton	0	0	-----	0	-----	0	3	0	0	0	0	4
Pennsylvania:												
Philadelphia	1	0	-----	0	1	1	6	7	2	0	2	112
Pittsburgh	0	0	-----	0	1	0	2	6	6	0	0	37
Reading	0	0	-----	0	1	0	1	0	1	0	0	-----
EAST NORTH CENTRAL												
Ohio:												
Cincinnati	0	0	-----	0	-----	0	2	15	2	0	0	3
Cleveland	1	0	1	0	6	0	8	16	2	0	0	151
Columbus	1	0	-----	0	2	0	1	9	2	0	0	21
Indiana:												
Fort Wayne	0	0	-----	0	-----	0	0	0	1	0	1	-----
Indianapolis	0	0	-----	0	-----	0	0	2	0	0	2	9
South Bend	0	0	-----	0	-----	0	0	0	0	0	0	-----
Terre Haute	0	0	-----	0	1	0	2	0	0	0	0	2
Illinois:												
Chicago	0	0	-----	0	22	2	16	46	8	0	2	56
Michigan:												
Detroit	0	0	-----	1	4	0	7	28	7	0	0	120
Flint	0	0	-----	0	-----	0	2	3	3	0	0	-----
Grand Rapids	0	0	-----	0	5	0	0	0	1	0	0	25
Wisconsin:												
Kenosha	0	0	-----	0	-----	0	0	0	0	0	0	5
Milwaukee	0	0	-----	0	8	0	0	5	0	0	0	29
Racine	0	0	-----	0	4	0	0	3	1	0	0	15
Superior	0	0	-----	0	-----	0	0	0	0	0	0	2
WEST NORTH CENTRAL												
Minnesota:												
Duluth	0	0	-----	0	6	0	0	0	0	0	0	45
Minneapolis	0	0	-----	0	10	0	3	1	3	0	0	21
Missouri:												
Kansas City	0	0	-----	0	-----	0	2	2	5	0	1	8
St. Joseph	0	0	-----	0	-----	0	0	2	0	0	0	-----
St. Louis	2	0	-----	0	7	0	6	0	0	0	2	23

[1] In some instances the figures include nonresident cases.

City reports for week ended August 30, 1947—Continued

Division, State, and City	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
WEST NORTH CENTRAL—continued												
North Dakota:												
Fargo	0	6	------	0	3	0	0	3	0	0	0	4
Nebraska:												
Omaha	0	0	------	0	3	1	1	2	2	0	0	18
Kansas:												
Topeka	0	0	------	0	------	0	0	0	0	0	0	9
Wichita	0	0	------	0	------	0	5	0	0	0	0	2
SOUTH ATLANTIC												
Delaware:												
Wilmington	0	0	------	0	------	0	2	15	1	0	0	------
Maryland:												
Baltimore [1]	7	0	------	0	2	0	4	3	2	0	2	100
Cumberland	1	0	------	0	------	0	0	1	0	0	0	2
Frederick	0	0	------	0	------	0	0	0	0	0	0	------
District of Columbia:												
Washington	0	0	------	0	5	0	3	1	2	0	0	26
Virginia:												
Lynchburg	0	0	------	0	3	0	0	1	1	0	0	------
Richmond	0	0	------	0	1	0	0	2	0	0	0	5
Roanoke	0	0	------	0	------	0	0	0	0	0	0	------
West Virginia:												
Charleston	0	0	------	0	------	0	0	1	0	0	0	1
Wheeling	0	0	------	0	------	0	0	0	0	0	0	------
North Carolina:												
Raleigh	0	0	------	0	------	0	0	0	0	0	0	------
Wilmington	1	0	------	0	------	0	1	0	1	0	0	4
Winston Salem	0	0	------	0	1	0	1	0	1	0	0	4
South Carolina:												
Charleston	0	0	------	0	------	0	1	0	1	0	2	------
Georgia:												
Atlanta	0	0	1	0	2	0	2	0	0	0	0	------
Brunswick	0	0	------	0	------	0	1	0	0	0	0	------
Savannah	0	0	------	0	------	0	0	0	0	0	0	12
Florida:												
Tampa	0	0	2	0	------	0	3	0	1	0	0	2
EAST SOUTH CENTRAL												
Tennessee:												
Memphis	0	0	------	0	1	0	6	0	1	0	2	6
Nashville	0	0	------	0	1	0	1	0	0	0	0	3
Alabama:												
Birmingham	0	0	------	0	------	0	1	0	0	0	0	------
Mobile	0	0	------	0	------	0	1	0	0	0	0	1
WEST SOUTH CENTRAL												
Arkansas:												
Little Rock	0	0	------	0	------	0	1	0	0	0	1	2
Louisiana:												
New Orleans	1	0	------	0	2	0	3	1	1	0	1	5
Shreveport	0	0	------	0	------	0	5	0	0	0	0	------
Oklahoma:												
Oklahoma City	0	0	1	0	------	0	1	1	0	0	0	5
Texas:												
Dallas	0	0	------	0	------	0	2	0	1	0	0	4
Galveston	0	0	------	0	------	0	0	0	0	0	0	------
Houston	0	0	------	0	------	0	3	2	1	0	0	1
San Antonio	0	0	------	0	------	0	3	0	0	0	0	3
MOUNTAIN												
Montana:												
Billings	0	0	------	0	------	0	0	0	0	0	0	------
Helena	0	0	------	0	------	0	0	0	1	0	0	------
Missoula	0	0	------	0	------	0	0	0	0	0	0	------
Idaho:												
Boise	0	0	------	0	------	0	0	5	2	0	0	------
Colorado:												
Denver	3	0	------	0	1	0	1	0	2	0	0	29
Pueblo	0	0	------	0	0	0	0	0	0	0	0	1
Utah:												
Salt Lake City	0	0	------	0	7	0	1	0	2	0	0	2

[1] Beginning with the current report, deaths reported in Baltimore will include deaths of residents only; prior to this date all deaths occurring in the city have been included.

City reports for week ended August 30, 1947—Continued

Division, State, and City	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
PACIFIC												
Washington:												
Seattle	2	0	------	0	2	0	2	1	0	0	0	7
Spokane	0	0	------	0	0	0	2	5	0	0	0	1
Tacoma	0	0	------	0	2	0	0	3	0	0	0	------
California:												
Los Angeles	6	0	2	1	3	1	3	14	7	0	1	41
Sacramento	2	1	------	0	------	0	0	0	1	0	0	5
San Francisco	0	0	------	0	24	0	1	0	2	0	0	------
Total	39	7	10	2	200	9	193	282	100	0	21	1,240
Corresponding week, 1946*	66	------	45	0	145	------	191	------	153	0	37	738
Average 1942–46*	48	------	24	[3] 5	[4] 154	------	[3] 202	------	199	0	30	793

*Exclusive of Oklahoma City.
[3] 3-year average, 1944–46.
[4] 5-year median, 1942–46.

Dysentery, amebic.—Cases: Boston, 1; New York, 1; St. Louis, 1.
Dysentery, bacillary.—Cases: Providence, 3; Baltimore, 1; Charleston, S. C., 1; Los Angeles, 1.
Dysentery, unspecified.—Cases: San Antonio, 7.
Leprosy.—Cases: New Orleans, 1.
Rocky Mountain spotted fever.—Cases: St. Louis, 1.
Tularemia.—Cases: Roanoke, 1.
Typhus fever, endemic.—Cases: New York, 1; Tampa, 1; New Orleans, 1; Dallas, 1; Savannah, 1.

Rates (annual basis) per 100,000 population, by geographic groups, for the 88 cities in the preceding table (latest available estimated population, 34,249,200)

	Diphtheria case rates	Encephalitis, infectious, case rates	Influenza		Measles case rates	Meningitis, meningococcus, case rates	Pneumonia death rates	Poliomyelitis case rates	Scarlet fever case rates	Smallpox case rates	Typhoid and paratyphoid fever case rates	Whooping cough case rates
			Case rates	Death rates								
New England	10.5	0.0	2.6	0.0	47	0.0	57.5	99.3	21	0.0	0.0	243
Middle Atlantic	3.7	0.0	0.9	0.0	20	2.3	28.2	23.6	11	0.0	1.9	142
East North Central	1.2	0.0	0.6	0.6	32	1.2	23.3	77.9	17	0.0	3.1	269
West North Central	4.5	13.4	0.0	0.0	65	2.2	37.8	22.3	22	0.0	6.7	289
South Atlantic	14.7	0.0	4.9	0.0	23	0.0	29.4	39.2	16	0.0	6.5	255
East South Central	0.0	0.0	0.0	0.0	12	0.0	53.1	0.0	6	0.0	11.8	59
West South Central	2.5	0.0	2.5	0.0	5	0.0	45.7	10.2	8	0.0	5.0	51
Mountain	25.0	0.0	0.0	0.0	67	0.0	16.6	41.6	58	0.0	0.0	266
Pacific	15.8	1.6	3.2	1.6	49	1.6	12.7	36.4	16	0.0	1.6	85
Total	6.0	1.1	1.5	0.3	31	1.4	29.5	43.1	15	0.0	3.2	189

PLAGUE INFECTION IN SAN LUIS OBISPO COUNTY, CALIF.

Plague infection was reported proved on September 3 in a pool of 200 fleas from 25 ground squirrels, *Citellus beecheyi*, taken from the Santa Margarita Ranch, Highway No. 101, Santa Margarita, San Luis Obispo County, Calif.

TERRITORIES AND POSSESSIONS

Panama Canal Zone

Notifiable diseases—July 1947.—During the month of July 1947, certain notifiable diseases were reported in the Panama Canal Zone and terminal cities as follows:

Disease	Residence [1]									
	Panama City		Colon		Canal Zone		Outside the zone and terminal cities		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Chickenpox	13		2		2		6		23	
Diphtheria	27						13	1	40	1
Dysentery:										
Amebic	1						4	1	5	1
Bacillary	3		6		4		1		14	
Leprosy							1		1	
Malaria [2]	11	1	2		37		352	8	402	9
Measles	5				1		1		7	
Mumps					2		1		3	
Paratyphoid fever				1						1
Pneumonia		3		3	19	1		3	[3] 19	10
Poliomyelitis					5				5	
Tuberculosis		18		6	6	1		7	[3] 6	32
Typhoid fever							2		2	
Typhus fever	1								1	

[1] If place of infection is known, cases are so listed instead of by residence.
[2] 17 recurrent cases.
[3] In the Canal Zone only.

FOREIGN REPORTS

CANADA

Provinces—Communicable diseases—Week ended August 16, 1947.—During the week ended August 16, 1947, cases of certain communicable diseases were reported by the Dominion Bureau of Statistics of Canada as follows:

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Chickenpox		6		18	76	11	12	12	28	163
Diphtheria		3		9	2	1		1		16
Dysentery:										
Amebic					3					3
Bacillary				1						1
Unspecified					1					1
Encephalitis, infectious						2				2
German measles				2	20		2	2	3	29
Influenza		144			13	5				162
Measles		2		67	78	11	7	12	24	201
Meningitis, meningococcus				2		1	1		3	7
Mumps		10		15	149	9	6	9	10	208
Poliomyelitis		11	2	18	30	86	33	5	21	206
Scarlet fever				34	14			3	2	53
Tuberculosis (all forms)			13	59	21	33	22	17	16	181
Typhoid and paratyphoid fever		1	1	18	1			1	2	24
Undulant fever				13	2	1				16
Venereal diseases:										
Gonorrhea	6	19	8	98	97	52	27	45	77	429
Syphilis		11	6	55	48	12	6	8	30	176
Other forms									2	2
Whooping cough				20	94	20	8	21	10	173

GREAT BRITAIN

England and Wales—Poliomyelitis.—During the week ended August 23, 1947, 676 cases of poliomyelitis were reported in England and Wales, a decrease from the preceding week, bringing the total number of cases reported to date to 3,619. This is the first week since the beginning of the epidemic in which a decrease in the number of reported cases occurred.

WORLD DISTRIBUTION OF CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER

From consular reports, international health organizations, medical officers of the Public Health Service, and other sources. The reports contained in the following tables must not be considered as complete or final as regards either the list of countries included or the figures for the particular countries for which reports are given.

CHOLERA

[C indicates cases]

NOTE.—Since many of the figures in the following tables are from weekly reports, the accumulated totals are for approximate dates.

Place		January–June 1947	July 1947	August 1947—week ended—				
				2	9	16	23	30
ASIA								
Burma	C	234	21					
Moulmein	C	64						
Rangoon	C	3						
China:								
Foochow	C		2					
Formosa (Island of)	C	14						
Hong Kong	C	6						
Shanghai	C			[1] 1	[1] 1	1	1	
Wenchow	C		1					
India	C	48,750	10,912					
Bombay	C	[1] 2	46	19	13	81	[1] 2	
Calcutta	C	3,743	202	30	48	38	20	
Cawnpore	C	18	8	12	21	43	28	
Chittagong	C	[3] 14	12	3				
Lucknow	C	25	166	6	1	15		
Madras	C	3						
India (French)	C	62	1					
Indochina (French):								
Cambodia	C	594	261		[3] 9			
Cochinchina	C	403	9		[3] 5			
Bien Hoa	C	7						
Chaudoc	C		1					
Cholon	C	33						
Giadinh	C	11						
Longxuyen	C	6						
Mytho	C	5						
Rachgia	C	19						
Saigon	C	133						
Vinh-long	C	8						
Laos	C	3	18		[3] 6			
Tonkin	C	3	1					
Siam (Thailand)	C	2,493	417	9				
Bangkok	C	726	33	8	2		2	

[1] Imported.
[2] Includes imported cases.
[3] For the period Aug. 1–10, 1947.

PLAGUE

[C indicates cases]

AFRICA								
Belgian Congo	C	[1] 12						
British East Africa:								
Kenya	C	39	7	1	1			
Uganda	C	1						
Egypt: **Alexandria**	C	4	13	1				
Madagascar	C	[2] 166	10					
Union of South Africa	C	19	[3] 5					
ASIA								
Burma	C	1,174	26	11	7	8		
Bassein	C	[4] 2						
Mandalay	C	17						
Rangoon	C	14			1	1		

[1] Includes 5 cases of pneumonic plague.
[2] Includes 50 cases of pneumonic plague.
[3] Includes 2 cases of pneumonic plague.
[4] Imported.

PLAGUE—Continued

[C indicates cases]

Place		January–June 1947	July 1947	August 1947—week ended— 2	9	16	23	30
ASIA—continued								
China:								
Chekiang Province	C	109	2					
Fukien Province	C	513	14					
Amoy	C	13						
Foochow	C	6	15					
Kiangsi Province	C	116	4					
Nanchang	C	35						
Kiangsu Province: Shanghai	C	28						
Kwangtung Province	C	53						
Yunnan Province	C	50						
India	C	66,264	205					
Indochina (French):								
Annam	C	34	10				[6] 20	
Cochinchina	C	26	1		3			
Java	C	[6] 37						
Korea	C	22						
Palestine	C	2	17	15	1	1		
Siam (Thailand)	C	31						
Syria	C	6						
Turkey: Akcakale	C	19						
EUROPE								
Germany: East Prussia.[7]								
Portugal: Azores	C	1	1					
Turkey (see Turkey in Asia).								
SOUTH AMERICA								
Argentina:								
Cordoba Province	C	1						
Santa Fe Province	C	2	1					
Brazil:								
Ceara State	C	2						
Minas Geraes State	C	7						
Pernambuco State	C	1						
Ecuador:								
Chimborazo Province	C	2	2					
Loja Province	C	5						
Peru:								
Lambayeque Department	C	4	1					
Libertad Department	C	8	9					
Lima Department	C	18	6					
Piura Department	C	[8] 78						
OCEANIA								
Hawaii Territory: Plague infected rats [9]		1						

[5] For the period Aug. 1–10, 1947.
[6] Includes imported cases.
[7] During the month of June 1947, an outbreak of plague with high mortality occurred in Konigsburg, East Prussia, Germany.
[8] In addition 82 cases with 65 deaths in Ayabaca Province and 58 cases with 48 deaths in Huancabamba Province, all unconfirmed, were reported for the period September 1946 to March 1947.
[9] Plague infection was also reported in Hawaii Territory as follows: On Jan. 9, 1947, in a pool of 31 rats; on Mar. 20, 1947, in a pool of 32 fleas collected from 59 rats.

SMALLPOX

[C indicates cases; P, present]

Place		January–June 1947	July 1947	August 1947—week ended— 2	9	16	23	30
AFRICA								
Algeria	C	98						
Angola	C	[1] 15						
Basutoland	C	1						
Bechuanaland	C	17						
Belgian Congo	C	872	149	89	71			
British East Africa:								
Kenya	C	302	11	1	18	2		
Nyasaland	C	561	106					
Tanganyika	C	1,155	375	126				
Uganda	C	191	32	4	5			

[1] Includes alastrim.

SMALLPOX—Continued

[C indicates cases; P, present

Place		January-June 1947	July 1947	August 1947—week ended—				
				2	9	16	23	30
AFRICA—continued								
Cameroon (French)	C	83	3					
Dahomey	C	132						
Egypt	C	417	78					
Ethiopia	C	29						
French Equatorial Africa	C	5						
French Guinea	C	315	6					
Gambia	C	5	1					
Gold Coast	C	561	4					
Ivory Coast	C	1,577	127				[2] 308	
Liberia	C	37						
Libya	C	1,932	59			23	16	
Mauritania	C	22						
Morocco (French)	C	56						
Morocco (Int. Zone)	C	12						
Morocco (Spanish)	C	27						
Mozambique	C	1						
Nigeria	C	2,424						
Niger Territory	C	2,222	15					
Portuguese Guinea	C	3						
Rhodesia:								
Northern	C	14	26		3			
Southern	C	312						
Senegal	C	15						
Sierra Leone	C	292						
Sudan (Anglo-Egyptian)	C	[1] 142	37	12	15	7	8	
Sudan (French)	C	357	6					
Swaziland	C	10						
Togo (French)	C	85						
Tunisia	C	527	17					
Union of South Africa	C	395	P		P		P	
ASIA								
Burma	C	2,580	70	4	12	13		
Ceylon	C	1						
China	C	2,696	112					
India	C	42,194	2,584					
India (French)	C	10						
India (Portuguese)	C	3						
Indochina (French)	C	3,316	244					
Iran	C	46						
Iraq	C	14						
Japan	C	366	8	1		1		
Korea	C	125						
Malay States (Federated)	C	2,923	154	22	26			
Manchuria	C	5	1					
Siam (Thailand)	C	1,088	7	6				
Straits Settlements	C	98						
Syria	C	2						
Turkey (see Turkey in Europe).								
EUROPE								
Belgium	C	[1] 23						
France	C	43	3	1				
Germany	C	12						
Great Britain: England and Wales	C	72	5					
Greece	C	10						
Irish Free State	C		[3] 1					
Italy	C	66						
Luxemburg	C	[1] 2						
Portugal	C	23	4		1			
Spain	C	18						
Switzerland	C		[3] 1					
Turkey	C	3						
NORTH AMERICA								
Guatemala	C	11						
Mexico	C	449	91					
Panama (Republic)	C		[3] 1					

[1] Includes alastrim.
[2] For the period Aug. 1-20, 1947.
[3] Imported.

SMALLPOX—Continued

[C indicates cases; P, present]

Place		January–June 1947	July 1947	August 1947—week ended—				
				2	9	16	23	30
SOUTH AMERICA								
Argentina	C	2	17					
Brazil	C	229	2	1	2	2		
Colombia	C	2,237	383					
Ecuador	C	[1] 175	[1] 143					
Paraguay	C	[1] 100						
Peru	C	213	5					
Uruguay	C	183				[1] 18		
Venezuela	C	[1] 2,599	[1] 81		[1] 116		[1] 37	

[1] Includes alastrim.

TYPHUS FEVER*

[C indicates cases; P, present]

AFRICA								
Algeria	C	113						
Basutoland	C	10	1					
Bechuanaland	C	1						
Belgian Congo	C	214	26	7	5			
British East Africa:								
Kenya	C	7	1					
Uganda	C	1	1					
Egypt	C	76	12					
Eritrea	C	420	18	21	11			
Ethiopia	C	87	21					
French West Africa [1]	C	2						
Gold Coast	C	5						
Libya	C	138	5	4	3	5		
Morocco (French)	C	106	8		1		1	
Morocco (International Zone)	C	13						
Morocco (Spanish)	C	83						
Nigeria	C	3						
Rhodesia, Southern	C	1						
Sierra Leone	C	2						
Tunisia	C	616	17					
Union of South Africa	C	193	P		P		P	
ASIA								
Arabia	C	1						
Burma	C	3						
China [2]	C	61	10	2				
India	C	7						
Indochina (French)	C	29	12					
Iran	C	194	2					
Iraq	C	167	40	15	7	8	14	
Japan	C	869	91	16	6	4		
Java	C	1						
Korea	C	1,261						
Malay States (Federated) [1]	C	42						
Manchuria	C	3	7					
Palestine [2]	C	102	1		2			
Straits Settlements	C	2						
Syria	C	28						
Trans-Jordan	C	14	4					
Turkey (see Turkey in Europe).								
EUROPE								
Austria [2]	C	5	2					
Bulgaria	C	712	4	11				
Czechoslovakia	C	24		1				
France	C	4						
Germany	C	18	6					
Great Britain: Malta and Gozo [1]	C	5	2	2				
Greece [2]	C	147	18	10	20	13	2	12
Hungary	C	555	8	4	2	1		

*Reports from some areas are probably murine type, while others probably included both murine and louse-borne types.

[1] Murine type.

[2] Includes murine type.

TYPHUS FEVER—Continued

[C indicates cases; P, present]

Place		January–June 1947	July 1947	August 1947—week ended—				
				2	9	16	23	30
EUROPE—continued								
Italy	C	30						
Sicily	C	19						
Netherlands	C	1						
Poland	C	372	14					
Portugal	C	2						
Rumania	C	15,481						
Spain	C	90						
Switzerland [1]	C	6						
Turkey	C	402	22		12	13	2	10
Yugoslavia	C	132	20	2				
NORTH AMERICA								
Costa Rica [1]	C	89	4					
Cuba [1]	C	4						
Guatemala	C	215						
Jamaica [1]	C	23	6					
Mexico	C	1,034	180					
Panama Canal Zone	C	9						
Panama (Republic)	C	[3] 16	1					
Puerto Rico [1]	C	27	3	1	1	2	1	
SOUTH AMERICA								
Argentina [2]	C	13						
Brazil	C	5						
Chile [2]	C	249						
Colombia	C	1,020	245					
Ecuador [2]	C	262	53					
Peru	C	517						
Venezuela [2]	C	81						
OCEANIA								
Australia [1]	C	72	11					
Hawaii Territory [1]	C	14	7	1			2	1

[1] Murine type.
[2] Includes murine type.
[3] Includes imported cases.

YELLOW FEVER

[C indicates cases; D, deaths]

SOUTH AMERICA								
Colombia:								
Antioquia Department	C	[1] 3						
Boyaca Department	D	1						
Caldas Department	D	4	2					
Cundinamarca Department	D	2						
Intendencia of Meta	D	4						
Santander Department	D	27						
Tolima Department	D	3						

[1] Includes 1 fatal case.

FEDERAL SECURITY AGENCY

UNITED STATES PUBLIC HEALTH SERVICE

THOMAS PARRAN, *Surgeon General*

DIVISION OF PUBLIC HEALTH METHODS

G. ST. J. PERROTT, *Chief of Division*

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